Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XL. No. 1.

SOLENODON PARADOXUS.

BY

GLOVER M. ALLEN.

With Nine Plates.

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Printed for the Museum.
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INTRODUCTION.

The Museum has recently been fortunate in securing from San Domingo, a series of specimens of the rare *Solenodon paradoxus* Brandt. Four of these were brought alive, and were successfully photographed by Mr. George Nelson. The more interesting of the photographs were reproduced with the Annual Report of the Curator for 1907–08. The present paper is a comparative account of the general anatomy of the species, made possible by this fresh material. For the loan of its specimens of *Solenodon cubanus* thanks are due the United States National Museum.

HISTORY.

The brief history of this species is now well known. It was originally described in 1833 by J. F. Brandt from a skin and an imperfect skull, in the St. Petersburg Academy, from Haiti. This specimen was subsequently studied by Peters in connection with the Cuban species, described by him in 1864. Leche states that he too, made use of this skull and other fragments of the skeleton, when in 1907 he published his extensive paper on the teeth of the Insectivora. The exact nature of the other fragments is not stated but from the text it appears that a pelvis with the sacral vertebrae labeled as of this species, was among the material studied. These bones were figured by Leche who called attention to the remarkable characters shown by them in comparison with those of other Insectivora. There can be no doubt, as will be shown later, that the pelvic and sacral bones figured are not those of Solenodon. Through the labors of Peters and Dobson, the anatomy of *Solenodon cubanus* was fairly well known more than twenty years ago, but no additional specimens of *S.*

paradoxus were discovered until 1907, when A. Hyatt Verrill secured an adult male, an adult female, and a young individual still retaining its milk dentition. Of these specimens, Dr. J. A. Allen (:08) has given a brief account. The skulls and dentition are well figured by him and critical comparison is made with skulls of *S. cubanus*. The preservation of the skin and soft parts of the specimens was too poor to admit of further detailed study, however. A brief paper by Verrill (:07) recounts the few facts he was able to glean as to the habits of these animals in San Domingo. The present account will, it is hoped, serve partially to fill the hiatus existing in our knowledge of the general anatomy of the species.

Specimens of the Cuban Solenodon, were made known by Poey in 1834, through a communication to a Havana paper, "El plantel." Later, in 1851, he gave a more detailed notice of the animal, with a colored plate, in his "Memorias sobre la historia natural de la isla de Cuba." Poey obtained specimens from the mountainous regions east of Bayamo, Cuba, where the animal was said to be well known. This author reviews at some length the early accounts of the native Cuban animals, and after an exhaustive search, fails to find any evidence that it was known to the early historians of the country. Since he was unable to attach to it any of the native names of animals mentioned by these writers, he proposed to call it the Almiqui, a name derived from that of one of the mountains in the eastern department of Cuba near where his specimens were taken. He supposed the Cuban animal to be conspecific with that of Haiti and San Domingo. Gundlach subsequently obtained examples from the Sierra Maestra, but Ramon de la Sagra's statement that it occurs in the region of Trinidad, Cuba, Poey takes pains to show, is based solely on the latter's note in "El plantel" concerning vague reports of an animal in that region whose identity could not be certainly established.

According to A. H. Verrill (:07, p. 56), the natives of San Domingo have various names for *Solenodon paradoxus*, as Orso (bear), Hormigero (ant-eater), Juron (ferret) "also applied to the mongoose," and Milqui. In his list of the mammals of Middle America and the West Indies Elliot gives it a vernacular name "Agouta," whose origin I have been unable to discover.

HABITS.

Of the habits of this species in a wild state very little is definitely known. According to Verrill's (:07) account it is "nocturnal, and spends the day in caves, holes in the coral limestone rocks and in hollow trees and logs." At night it leaves its retreat and comes forth to feed, "rooting in the earth and cultivated grounds, tearing rotten logs and trees to pieces with its powerful front claws, and feeding on ants, grubs, insects, vegetables, reptiles, and fruit, and at times proving destructive to poultry. On several occasions it has been known to enter the houses in search of roaches and other vermin, and has been captured in rat-traps." Mr. Verrill's wash drawing shows the animal with tail bent around at the side of the body, and the mounted specimen in the American Museum of Natural History is prepared in a similar manner. Such a posture for the tail is, however, probably never assumed, as its stiffness admits of but slight lateral flexure, and the muscle masses actuating its movements are almost wholly dorsal and ventral. In the living animals the tail is held straight out behind, somewhat depressed, but slightly elevated at the tip to permit it to clear the ground. The tip alone seems capable of slight lateral movement. The tail serves very effectively as a support when the animal is eating. It then throws itself back, with the soles of the hind feet resting their full length on the ground, and the powerful tail acting as a third leg of a tripod. In this position one or both of the fore feet can be lifted from the ground.

In feeding, the animals walk clumsily about with a stiff waddling gait, sniffing here and there at the objects that come in their path. The toes only are in contact with the ground as they walk, while the metatarsals are quite clear. They eat greedily of chopped meat, and will take lettuce as well by way of variety. Meat they give considerable mastication, opening the jaws widely as they chew. That they are capable of very quick movements, in spite of their apparent clumsiness, is seen when two or three are eating together and disagree as to the possession of some morsel of food. If one attempts to rob another, like a flash the possessor of the dainty throws its body around away from the pursuer and continues chewing greedily. Often one will seize its companion by the snout, and if wickedly inclined can bite severely. Usually, however, they seem peaceful enough. Rarely a shrill cry is uttered, as Mr. George Nelson tells me, who has heard it while tending the captive specimens. At other times, they constantly give an explosive sniff as if clearing the nose. They are mainly active at night or in the late afternoon, and seem to dig over

and under every movable article in the cage. They have a pronounced odor, not disagreeable, and reminding one slightly of that of a goat or a porcupine, yet characteristically different.

Verrill states that a female in his possession gave birth to three young, which, however, she promptly devoured. One of the females in the lot belonging to the Museum likewise brought forth her young in captivity, but in this case but a single one was found. If others were born, they too must have been devoured. This young one when probably a day or so old had the eyes and ears still closed. The hair was beginning to appear, although not sufficiently to clothe the body. It was a female (Plate 1, fig. 1) and had the single pair of mammae well developed. It lived but three days, at the end of which time the first upper and the two first lower incisors were erupted, but the eyes and the ears were as yet unopened.

EXTERNAL APPEARANCE.

In general form Solenodon is shrew-like, with a long tapering snout, elongate head and a stout tail. The feet and limbs are not notably modified, though the fore claws are greatly developed. The great development of the snout beyond the nasal bones is a striking peculiarity, shared, however, to some extent by the African genera Macroscelides and Rhynchocyon. This proboscis in *Solenodon paradoxus* is cartilaginous, and consists of a long tube, quadrangular in section (Plate 5, fig. 2) and deeper than wide. The nasal septum divides the cavity of the proboscis and is continued into the nasal chamber; a projecting ridge on each side of the septum, partly divides the lumen of the proboscis into a dorsal and a ventral tube. At its proximal end the proboscis is ventrally supported by a small round bone, the os proboscidis, and laterally it is held in place by a short triangular cartilage on each side from the upper free edges of the premaxillaries. These cartilages are loosely bound to the sides of the proboscis by connective tissue. The tip of the snout has a naked rhinarium about a centimeter in length ventrally whose posterior border is ill defined dorsally just posterior to the nostrils, but below it is sharply marked off from the surrounding haired surfaces by a slight groove. A median groove runs from the upper incisors to the tip of the snout which here is slightly emarginate. The nostrils open laterally and are somewhat crescentiform. The sides of the snout are supplied with about a dozen large vibrissae, the longest of which measure about 65 mm. There are in addition shorter hairs from swollen bases, that are coarser

than those surrounding and are doubtless tactile. A single vibrissa 25 mm. long is present on the midline of the chin below the angle of the mouth. Two or three long coarse hairs are also found midway between the eye and the ear.

The ear is large, and nearly round in general outline, though the anterior margin is straight. A large posterior basal lobe is marked off by a conspicuous notch halfway on the posterior border. A smaller lobe is similarly indicated at the base of this larger lobe. The whole appears to be comparable with the antitragus of other mammals. On its internal surface is a rounded ridge. This and the more ectal portion of the antitragus are thinly covered by hair. The tragus, at the base of the antero-internal border of the ear, is a barely indicated marginal prominence. A prominent metatragus is well developed, just below and anterior to the center of the ear. It consists of a large rounded lobe anteriorly with a short small ridge-like projection just posterior and parallel to it. These two prominences are placed slightly obliquely to the vertical axis, inclined forward. From the notch separating postero-dorsally the antitragal lobe, a prominent ridge is developed, with a somewhat crescentiform outline, the concavity ventral, projecting inward nearly a third the diameter of the ear. There is on each ear, directly above this ridge and about 3 mm. from the posterior rim of the conch, a low round papilla. The border of the ear is slightly emarginate above this papilla, a result possibly of injury, since the two notches are not of exactly the same appearance in the two ears. The distal half of both inner and outer surfaces of the conch is sprinkled with minute appressed hairs. The ear of *S. cubanus* is slightly larger.

The body is round and stout, the limbs heavy and muscular. The latter present no remarkable modifications, but the claws of the anterior digits are greatly developed, apparently for scratching the surface rather than for burrowing in the earth. In the Cuban Solenodon they are absolutely longer and more slender, although the animal itself is smaller. The three middle digits of fore and hind feet are subequal. The innermost digit is in each case the shortest. The hind foot is of a very generalized type, and with long metatarsal bones suited to the semi-plantigrade method of walking.

The tail is long and stout in *S. paradoxus*, though rather more slender, relatively, than in *S. cubanus*. In both it is covered at the base by dense hairs, fine and very short, which extend forward to the posterior part of the rump, where the long hairs abruptly stop. The tail is covered with very small scales, between which are scattered minute hairs. Near the base of the tail there are about 36 scales in a single transverse row.

The mammae are two in number in both species, inguinal, or even post-inguinal, situated far apart, on a line just anterior to the genital opening. The number and position of the mammae are thus remarkably different from those in Centetes with its twelve pairs extending from the axillae to the groins. Potamogale, however, has but a single inguinal pair.

The general body hair is long and coarse dorsally, becoming finer and slightly crinkled on the sides and venter. On the back two sorts of hairs are distinguishable: (1) the abundant shorter and finer hairs, and scattered among these, (2) single coarse hairs. The latter appear to have larger follicles and these, in a skin of *S. cubanus* that has lost some of the hair, are seen to be arranged in oblique rows, at intervals in the dried skin of about 5 mm. In a young *Solenodon paradoxus* three days old (Plate 1, fig. 1), these coarse hairs are well developed, averaging some 5 mm. in length, and scattered at close intervals in similar oblique rows. With a hand lens the more abundant finer hairs may be seen at the bases of these larger ones. They are very minute and seem to be at least three between each two of the large bristles in a transverse row, while others are scattered between the rows. It seems not unlikely that the coarse spiny hairs present mainly in a longitudinal row on each side in the young of Centetes are homologous with these bristles in Solenodon. The further echinate development of the corresponding hairs in Centetes is seen in the adult that has scattered spine-like hairs over the dorsal area mingled with the more abundant finer hairs of the general body surface. The further development of a spiny dorsal covering such as is present in Erinaceus, would seem to be thus foreshadowed in these two genera. The statement of Verrill (:07) that the legs, snout, and tail are naked, and that the rump is bare, is not strictly correct. The rhinarium is quite hairless, as are also the soles of the feet, but the rest of the snout, legs, and rump are covered with minute hair, and small appressed hairs spring from between the scales of the tail.

Color.— In the series of skins at hand there is great variation in the extent and intensity of the colors, and this appears to be independent of sex. The commonest type (Plate 3) has the dorsal surface of the head from the base of the snout to the ears and nape, black. The basal half of the hairs is pale buff. About the eye the long hairs are reflexed in a sort of rosette, and their pale bases thus form an encircling light-colored area. The black-tipped hairs extend over the mid-dorsal area of the back to the rump and are everywhere intermingled with pale, nearly buff-colored hairs, that give thus a grizzled effect to the dorsum. Ventro-laterally from the median line, the black hairs decrease in number, while

the buff hairs become more numerous, so that on the sides of the body and on the forearm they produce a clear buff or cream buff. This color of the sides extends ventrally from the abdominal region to the upper part of the chest where it passes into a deep ferruginous, almost chestnut, over the ventral surface of the throat, upper chest, bases of the fore limbs and dorsally to the sides of the neck. The inguinal region also is ferruginous. The short hairs of the feet and distal portion of the snout are of the same buffy color as the venter, with a slight admixture of ferruginous hairs around the mouth. A whitish nuchal spot, about 15 by 10 mm. in extent, is present in all but one of the specimens, and seems to be a characteristic of the species. The presence of a white nuchal spot is due to the failure to meet of the two lateral pigment areas whose centers are on the sides of the neck, as has been elsewhere indicated by the writer. The condition of partial albinism thus produced has here become fairly permanent, so as to result in a definite pattern. A similar restriction of the dermal pigment of the tail has taken place, so that a varying length, usually nearly the distal half, is white.

Variations from the type of coloration above described occur through an increase or a decrease in the intensity of the pigment. One female shows a maximum of increase in the black of the dorsum. This color is deep on the head and extends to the elbows on each side, while on the back the admixture of buffy hairs is very slight until well down on the sides of the body the clear buff area is reached. The white nuchal spot exists in this specimen as a few scattered hairs, hardly noticeable. Ventrally the lower surface of the forearm and the inguinal region from tibia to tibia is suffused with ferruginous.

The opposite extreme is shown by another female in which the black is so dilute, not only on the dorsal area as a whole, but in the separate hairs, that it appears as a distinct brownish, nearly drab of Ridgway's Nomenclature of colors, grizzled with buff hairs. The latter become slightly tinged with rufous on the sides and venter.

The ferruginous tint (Plate 2) is exceptionally well developed in two large and apparently old females and in a third smaller animal, an adult male. In the brighter of the two old females the buffy hairs of the back and sides of the head and body and on all but the mid-ventral region are replaced by ferruginous, even the nuchal spot being of this tint. The ventral portion of the chest and the lower throat where the ferruginous is brightest in other specimens, have in this example become so intensified that they are nearly black. The third bright specimen above mentioned is the most brilliant. The dark throat area is nearly

maroon shading into deep ferruginous on the sides of the neck, while posteriorly the sides of the body and the venter are orange-rufous, somewhat more ferruginous on the lower surface of the arms and on the inguinal region. The nuchal spot in this specimen is bright buff.

A very young female (Plate 1, fig. 2) is much paler in color than any of the adults. The dorsal area has a general tone of brocolli brown due in part to the dilute pigmentation of the black hairs and the paleness of the buffy hairs, which are here of a light cream buff. This color also extends over the sides and mid-ventral region becoming more intense a buff on the inguinal region and on the lower throat and chest. The ferruginous tints of the adult are quite absent at this early age.

The long vibrissae are usually buffy or ferruginous, but sometimes black.

Between the various styles of coloration just described all gradations occur. The black of the dorsum may be so restricted as to cover but a narrow median area or it may extend almost to the ventral border of the body. Again it may be so intermixed with buffy hairs that instead of showing clear black it appears as a uniformly grizzled drab, with all intermediate gradations of coloring. The color of the underparts in the youngest specimens varies from a uniform buff to ochraceous-buff and ochraceous, but in the adults the buff is often confined to the sides and abdomen and shades into ochraceous on the inguinal region and into ferruginous on the chest and throat. Others, however, have the inguinal area buff like the sides and abdomen. Again, the ferruginous of the throat may extend ventrally upon the abdomen, reaching an extreme in the case of an old female that has the entire belly and sides suffused with this color. Some have the abdominal surface nearly clear drab. All the specimens show the white nuchal patch except one or two highly colored adults in which this area is suffused with the buff or the ferruginous of the sides and belly. The white spot varies from a narrow streak 6 mm. wide and 12 mm. long to a blotch about 20 by 25 mm.

The great difference in color between *S. paradoxus* and *S. cubanus* has been pointed out by Dr. J. A. Allen. In the Cuban species the pelage is finer and longer. The dorsum is more uniformly dark without the admixture of lighter hairs. The uniform dark color of the back continues on to the feet, the thighs, forearms and chest while the greater part of the head and part of the mid-ventral area are pale yellowish, or in alcoholic specimens nearly white.

External measurements.— The following measurements are of ten adults, a young male, and a second younger animal, a female, but three days old, born in

captivity. All but the last were alcoholic specimens. The last was measured shortly after its death. Measurements are in millimeters.

Sex.	Total length	Eye to tip of nose.	Eye to ear.	Height of ear from meatus.	Breadth of ear.	Incisors to tip of nose.	Length of rhinarium.	Chin to corner of mouth.	Manus with longest claw.	Pes with claw.	Olecranon to tip of longest claw.	Tail from anus.	Length of white tail tip.
♂	520	67	34	29	24	31	9.5	25	52	68	106	222	70
♂	561	71	31	31	26	35	10.5	32	57	70	111	254	—
♂	525	64	27	30	22	35	11.0	33	59	69	108	211	130
♂	526	69	35	29	24	38	11.5	29	55	68	110	240	128
♂	530	69	35	31	25	39	10.0	30	53	67	110	222	141
♂ [1]	365	58	24	26	22	32	11.0	25	49	61	88	154	77
♀	551	71	32	27	22	39	11.0	29	51	67	101	238	80
♀	528	65	30	28	22	35	9.0	26	51	68	104	242	121
♀	531	68	32	29	25	35	10.0	30	54	70	109	238	94
♀	545	72	36	29	24	40	10.0	35	51	68	107	240	138
♀	543	69	26	29	23	37	11.0	29	53	68	108	240	99
♀ [2]	195	33	15	9.3	8	18	5.5	11	25	33	47	72.5	—

This table shows that adults of both sexes are essentially alike in size, and present a comparatively small amount of variation in the measurements. As additional data for comparison the following measurements of two males and two females are given following the order in Dr. J. A. Allen's (:08, p. 512) paper:

	♂	♂	♀	♀
Length of head (in straight line)	120	127	119	127
Breadth of head in front of ears	44	51	44	52
Length of eyelids (fissure)	5	5	5.5	4
Distance of eyes from each other	28	30	27	33
Breadth of proboscis at base	18	17	20	17.5
Height of proboscis at middle	11	11	10	9
Height of proboscis at base	18	16	17	16
Distance between corners of mouth	30	26	26	35
Thickness of tail at middle	10	10	10	11
Length of hand to end of 3d digit (without claws)	34	41	37	42
" " 1st digit (without claw)	9.5	9.5	10.5	9.5
" " claw of 1st digit (over curvature)	8	11	10	10
" " 2d digit (without claw)	14	15	11.5	16
" " claw of 2d digit (over curvature)	18	21	19	17
" " 3d digit (without claw)	17	16	17	16
" " claw of 3d digit (over curvature)	18	21	19	17
" " 4th digit (without claw)	16	17	14	17
" " claw of 4th digit (over curvature)	17.5	20	18	17
" " 5th digit (without claw)	12	12	11	14
" " claw of 5th digit (over curvature)	11	11.5	10.5	11
Length of foot to end of middle digit (without claw)	59	59	60	64
" " 1st digit (without claw)	10	9.5	9	9
" " claw of 1st digit (over curvature)	7	8	7	8
" " 2d digit (without claw)	13	14.5	14	16.5

[1] Immature.

[2] Three days old.

	♂	♂	♀	♀
Length of claw of 2d digit (over curvature)	10.5	12	10	10
" " 3d digit (without claw)	14	16	13	14
" " claw of 3d digit (over curvature)	10.5	12	10	10
" " 4th digit (without claw)	14	16	12	14
" " claw of 4th digit (over curvature)	10.5	12	10.5	10
" " 5th digit (without claw)	13.5	13	11	14
" " claw of 5th digit (over curvature)	8.5	10	9	9.5

Cranial measurements.— An adult skull exhibits the following measurements: greatest length, 87; greatest median length, 82.8; basal length, 77; palatal length, 37; interorbital constriction, 15.8; breadth outside first incisors, 10.5; breadth outside second premolars, 17; greatest width between outer molar margins, 24; greatest prezygomatic breadth, 34.7; greatest postzygomatic breadth, 34; mastoid breadth, 27; occipital breadth, 19.7; maxillary toothrow (including incisors), 40; length of mandible, 58; greatest height at coronoid process, 26; length of mandibular toothrow, 35.5; width of condyle, 9; length of mandibular symphysis, 19.

SUPERFICIAL BODY MUSCLES.

The *sterno-facialis* is a thin sheet of muscular fibers arising from fasciae along the anterior part of the pectoralis. The fibers from opposite sides are somewhat interlaced on the throat. This sheet extends forward over the prominent thyroid glands to the mandibular symphysis and dorsally on to the sides of the face, becoming inserted by thin tendinous fibers into the skin of this region.

The *panniculus carnosus* is extraordinarily developed and thickened over the dorsal region, where it forms a tough, mainly tendinous sheet about 2 mm. thick. This sheet is attached to the tips of the dorsal spines by thin strands of muscle and tendon and to the vertebral edge of each scapula and the posterior third of the scapular crest. A few slight strands of tissue connect it with the ecto- and ento-pectorales ventrally, and its main insertion, after dipping beneath the ecto-pectoralis, is upon the antero-internal side of the humerus about a centimeter distal to the head. This insertion is tendinous and some 6 mm. long. Antero-dorsally this great investing sheet is more or less continuous with the thin muscular and tendinous sheet of trapezius muscles that covers the top of the head and neck and inserts along the anterior length of the scapular spine. Posteriorly the panniculus merges into a thin sheet investing the thigh as far as the knee and backward around the base of the tail. It is everywhere closely connected to the skin.

A flat strand of muscle from 2 to 5 mm. wide (Plate 4, fig. 1, *e*) arises from above the articulation of the 14th rib on each side and passes forward for about 60 mm. to become inserted into this great tendinous sheet some 30 mm. posterior to the axilla. This appears to be the *dorso-cuticularis,* and is apparently narrower than in Gymnura or Potamogale.

MUSCLES OF HEAD AND NECK.

Compared with Centetes, Gymnura, or Potamogale, the anterior muscles of the snout seem to show less complexity in Solenodon, but resemble more nearly those of Myogale as figured by Dobson, whose specimen of *Solenodon cubanus* was in too poor a state of preservation to permit of exact determination of these muscles.

The *platysma myoides* is a flat superficial muscle, well developed and firmly attached to the skin from the lambdoid crest forward along the sides of the face and lower jaw.

The *zygomaticus major* (Plate 5, fig. 1, *b*) is a relatively small muscle arising from the bony ledge of the antorbital pit just above the last premolar. It passes into a small round tendon at about the level of the anterior incisors, and running just to one side of the midventral line, inserts on the ventral portion of the tip of the cartilaginous proboscis. Its action is to depress the snout, but it evidently is of limited use, as the vertical play of the proboscis is not very great.

The *levator labii superioris proprius* (Plate 5, fig. 1, *c*) is a large muscle attached along the entire anterior edge of the orbit from the ventral border of the eye nearly to the dorsal line. It passes forward as muscle to the tips of the nasals where it becomes a flat tendon and runs to the tip of the proboscis below the median line.

The *levator labii superioris et erector vibrissarum* (Plate 5, fig. 1, *a*) originates anteriorly to the orbit, between the two muscles just described and ectal to the opening for the facial nerve. It is likewise more or less firmly attached to the antero-lateral face of the maxillary where it breaks into numerous small thread-like tendons that pass to the bases of the vibrissae with which the snout is well supplied. These fibers are firmly united by investing tissue and muscular strands to the side of the cartilaginous proboscis, to which they are undoubtedly able to impart a slight lateral motion. Ventrally this muscle is closely connected by tendinous tissue to the orbicularis oris. It is richly supplied with nerves.

Temporalis (Plate 5, fig. 1, *e*) is large, and arises along the median and parietal crests. Its main mass on the dorso-lateral surface of the skull is about 40 mm. long and 20 mm. broad. It passes ventro-laterally to a tendinous insertion at the tip of the coronoid process of the jaw and on its ental aspect.

A small muscle (Plate 5, fig. 1, *d*) arises from the lateral surface of the posterior zygomatic root and passes dorsal to the masseter as a narrow band some 5 mm. wide, to its insertion along the exterior base of the coronoid process for a distance of about 8 mm. This seems to correspond to what Dobson considers in Gymnura a second head of the temporalis. In Solenodon, however, it is quite separate from the temporalis throughout.

Another muscle, corresponding to Dobson's third head of the temporalis in Gymnura, arises much as in that form from the inner dorsal margin of the posterior zygoma, and curving downward and forward, is broadly inserted as a flat muscle in the hollow of the exterior face of the coronoid process.

The *masseter* originates along the posterior portion of the malar part of the zygoma for a distance of 7 mm., and is inserted along the postero-ventral surface of the ramus.

The *digastric* muscles (Plate 5, fig. 1, *f*) are rather small, arising along the inferior side of the lambdoid crests about a centimeter from the vertex of the skull. Each as it passes forward, tapers to a tendinous insertion at the tip of a small bony process on the inner ventral margin of the mandible about 13 mm. anterior to the angle of the jaw.

Pterygoideus internus is a short thickish sheet of muscle arising externally to the pterygoid on each side and inserting at the angle of the ramus.

Pterygoideus externus is smaller, and arises just externally to the last from the sphenoid region. It inserts on the lower jaw inside the neck of the mandibular condyle forward to the inferior dental foramen.

The *mylo-hyoid* arises as a thin sheet from the inner ventral margin of each ramus. There is a fairly well defined median raphe where the two elements, one from each side, are united. The fibers stretch across between the two rami, and posteriorly to the insertion at the antero-ventral margin of the basi-hyal. A deeper and a more superficial layer is with some difficulty to be distinguished in this muscle.

The *stylo-hyoid* is well developed and conspicuous. It is a narrow band arising from the ventral side of the mastoid process, and passing superficially to the digastric, is inserted on the side of the thyroid bone of the larynx. This muscle seems not to have been previously found in Solenodon. It is said

by Dobson to be "very feeble" in Centetes; but in Potamogale is well developed. Dobson's figure of the latter (Dobson, '82–'90, pl. 9, *st. h.*) shows this muscle in nearly the same proportions as in Solenodon.

The *sterno-hyoid* is the most ventral of the muscles of the throat. It arises from the inner or dorsal side of the second segment (mainly) of the sternum. This muscle is divisible into two elements, which, however, are so closely united in the mid-ventral line that the separation is not clearly defined until the investing tissue is removed. The sterno-hyoid is broadly inserted into the ventral surface of the thyrohyal cartilage.

The *sterno-thyroid* of each side is smaller than the corresponding sterno-hyoid, and arises just lateral to it. It passes forward along the side of the trachea to the thyroid cartilage, on to the side of which it is inserted by two short muscular branches.

The *crico-thyroid* is represented by short muscles on each side, that pass obliquely from the cricoid to the thyroid cartilage.

Beneath the mylo-hyoid on each side, from the symphysis for about 8 mm. posteriorly, arise the *genio-hyoids*. They are closely approximated medially and fill the space between the rami. They are inserted on the ventral side of the basi-thyrohyal.

The *genio-hyoglossus* is as usual, a thin flat sheet of muscle, arising from the basihyals and radiating out anteriorly to the tongue.

The *trapezius* muscles (Plate 4, fig. 1, *a*, *c*, *d*) arise along the mid-dorsal line from the vertebral spines to the occipital crest at the posterior edge of the skull, forming a broad thin sheet. They insert along the spine of the scapula beginning at about 15 mm. from its vertebral edge, forward for some 28 mm. A slight break indicates the division between the spino- and acromio-trapezius, but the latter and the clavo-trapezius are not clearly separable.

The *supracervico-cutaneus* (Plate 4, fig. 1, *b*) arises from the mid-dorsal line of the posterior half of the neck and passes ventrally to become confluent with the broad tendinous sheet attached to the skin along the front edge of the fore shoulder.

The *rhomboideus* arises underneath the trapezius, by two heads. The first consists of a single long band from the mid-dorsal portion of the neck from occiput to about halfway on its length. The second is a longer sheet from the last cervicals and first four or five dorsal spines. The muscle is inserted along the posterior inner border of the scapula from just below the angle along the entire vertebral margin. A similar partial division of this muscle was noted by Dobson

for *Solenodon cubanus,* and the homology of these two portions with the rhomboideus anticus and posticus respectively of Gymnura and Centetes is suggested. In Potamogale Dobson found these muscles coalesced to form a single sheet.

The *occipito-scapularis* (Plate 5, fig. 4, *b*) arises along the lambdoid crest for about 10 mm. lateral to the mid-dorsal line. It passes back to the postero-external face of the scapula about 6 mm. below the coraco-vertebral angle where it is broadly inserted along the vertebral edge of the scapula. Its length is about 80 mm.

The *sterno-mastoideus* (Plate 5, fig. 4, *g*) takes origin from the ventral surface of the presternum, where it is slightly overlapped by the ectopectoralis. It passes forward as a muscular band to a tendinous insertion at the lateral extremity of the lambdoid crest just above the ear. This tendon, as in Centetes and Gymnura is united with the tendon of the cleido-mastoideus as a common insertion. The *cleido-mastoideus* (Plate 4, fig. 4, *h*) takes origin from the antero-external edge of the ventral half of the clavicle.

The *levator claviculae* (Plate 5, fig. 4, *a*) is well developed and takes origin from the atlas only near the median line at the antero-ventral margin. It passes back as a narrow band to a tendinous insertion on the ectal edge of the metacromion just back from its tip.

The *splenius* arises along the dorsal line from about as far back as the fifth dorsal vertebra. Passing forward, it inserts along the mesial portion of the lambdoid crest from the vertex to just ental of the sterno-mastoid insertion. Anteriorly the portion arising from the first of the cervicals may be more or less readily separated from the posterior part of the muscular sheet.

The *complexus* arises from the transverse processes of the vertebrae from the fifth cervical to the sixth dorsal. It has the usual insertion under the splenius. A lateral and a more median portion may be distinguished.

The *rectus capitis posticus major* arises from just below the top of the neural spine of the axis and passes forward to its insertion beneath the lambdoid crest, in close union with the *rectus capitis posticus minor* whose origin is slightly more lateral.

The *obliquus capitis superior* originates from the tip of the transverse process of the atlas, and goes forward to its insertion below the lambdoid crest at a point about 7 mm. lateral to the vertex of the occiput. It is also united by a slight raphe to the ecto-proximal portion of the digastric muscle.

The *obliquus capitis inferior* is large and arises from the postero-lateral portion of the spine of the axis. Its course is obliquely forward to the posterior side of the transverse process of the atlas.

The *levator anguli scapulae* takes origin from the transverse processes of the three last cervical vertebrae and is inserted along the subscapular surface of the scapula, internal to the rhomboideus, from the coraco-vertebral angle to the insertion of the serratus magnus. In Centetes as in Gymnura and Potamogale this muscle is united with serratus magnus. In Myogale, however, the condition is practically the same as here described for Solenodon, though in the former the levator is slightly more developed.

MUSCLES OF THE TRUNK.

The *latissimus dorsi* (Plate 4, fig. 1, *f*) is a large superficial muscle, consisting of a thin sheet of fibers covering the dorsal half of the thorax from the last rib forward to about the ninth rib. It arises from the spines of these vertebrae as well. Antero-laterally it becomes a narrow tendon which inserts on the antero-internal face of the humerus near its head, ental to the insertion of the teres and just above it. At the antero-ventral edge, just before the muscle passes into the tendon it is connected by a raphe with the epitrochlearis and by a few strong fibers to the ventral edge of the teres. This peculiarity was noted by Dobson in the Cuban Solenodon. Along the ventral edge of the latissimus where it covers the thorax, a branch from each of the dorsal nerves takes exit.

The *serratus magnus* has the usual general origin from the anterior portion of the thorax. Its posterior extension reaches the ninth rib. The muscle is inserted along the posterior inner edge of the scapula at the gleno-vertebral angle.

The oblique muscles present no especial peculiarities. The *ectobliquus* arises from the pubic symphysis on either side and passes upward and forward on to about the lower half of the ribs to the ventral border of serratus magnus, and the front of the ilium. The *entobliquus* has a strong tendinous origin from the anterior end of the ilium and along the pubis to the midventral line. It passes as a thin sheet antero-ventrally to the median line and ventral border of the ribs.

The *rectus abdominis* originates as a partly tendinous thin sheet from the ventral third of the first rib. It passes back to unite just behind the xiphisternum with its fellow of the opposite side, and the two are inserted by muscular fibers on the anterior rim of the pubis for a distance of about 8 mm. each side of the symphysis.

As in Gymnura, Centetes, and Potamogale there is a clavicular portion to the *ectopectoralis*. The sternal portion of this muscle takes origin along the entire median length of the sternum from the tip of the manubrium to the base

of the expanded cartilaginous end of the xiphisternum. The fibers converge as they pass obliquely forward to the insertion, 16 mm. in length, along the antero-median edge of the middle third of the humerus. The clavicular portion of this muscle (Plate 5, fig. 4, *c*) originates from the ecto-posterior border of the clavicle and is more or less confluent distally with the main mass of the ectopectoralis, though practically distinct to the common insertion.

The *entopectoralis* (Plate 5, fig. 4, *f*) arises just underneath the ectopectoralis, from the antero-ventral margin of the second rib, posteriorly to the base of the last sternal rib as a thin flat sheet, that becomes thicker as its fibers converge anteriorly to a tendinous insertion 4 mm. long at the head of the humerus, on its median face, just ental to the bicipital groove. At about the insertion of the fifth rib, there is a slight division of this muscular sheet so that its origin may be said to consist of an anterior and a posterior portion. These two parts evidently correspond to the two divisions described in Centetes by Dobson, although in that genus they are somewhat more extensive and distinct.

The *subclavius* (Plate 5, fig. 4, *d*) is a very narrow band of muscle arising from a tendon on the anterior side of the first rib, at about 2 mm. dorsal to the sternum. It passes antero-dorsally to a tendinous insertion on the ental aspect of the clavicle just proximal to its articulation with the acromion. This muscle is about 30 mm. long and 2 mm. or less in width. In Centetes, according to Dobson, it is not present, but in Gymnura is developed about as in Solenodon.

About 3 mm. dorsal to the origin of subscapularis, is the large tendinous insertion of *scalenus secundus* or *anticus*. It arises from the transverse processes of all the cervical vertebrae except the atlas, by tendinous and muscular fibers.

Scalenus primus arises dorsally to the last, from the transverse processes of the 3d, 4th, and 5th cervicals and is inserted on the thorax as far back as the fourth rib, in close juxtaposition to the ventral border of serratus magnus. The brachial plexus takes exit between the two scaleni.

The scalenus muscles appear thus to be much like those of Centetes and Potamogale, and differ from those of Gymnura and Erinaceus in that the *anticus* is present, whereas in the last two, according to Dobson, it is absent.

MUSCLES OF THE FORE LIMB.

The *coracoideus* (Plate 5, fig. 5, *c*) arises by a conspicuous tendon from the ental face of the coracoid process. The caput breve is inserted on the inner mesial surface of the humerus at a point 13 mm. from its head; the caput longe passes as a tendinous band from 2 to 3 mm. wide expanding somewhat distally to its insertion on the postero-internal portion of the humerus just proximal to the epitrochlea. Dobson makes the brief statement that this muscle in Solenodon is very similar to that in Erinaceus and Centetes. In Gymnura and Myogale the muscle was not detected, while in Potamogale the caput longe was wanting.

The *subscapularis* (Plate 5, fig. 5, *a*) is strongly developed. It is attached on the subscapular surface of the scapula, and arises from three rather distinct sets of fibers: (1) a set originating along the coraco-vertebral margin of the scapula nearly to the coraco-vertebral angle; (2) fibers from the vertebral margin of the scapula near the insertions of levator anguli scapulae and serratus magnus; (3) a bundle of fibers arising along the glenoid margin of the scapula, partly on the ental surface of the latter. Tendinous fibers from these three divisions run forward as a large tendon to an insertion on the trochin of the humerus underneath that of the coracoideus.

The large *supraspinatus* (Plate 5, fig. 6, *i*) is from almost the entire supraspinous fossa except its most posterior portion, from the coraco-vertebral margin to the margin of the mesoscapula, becoming tendinous as it passes under the acromion to its insertion on the trochiter.

The *spino-deltoideus* arises along the mesoscapula from just posterior to the metacromion. It passes forward and slightly inward, to its insertion on the crista deltoidea of the humerus. Here it is joined by the *acromio-deltoideus* from the infraspinous border of the acromion, a smaller, narrower muscle.

The origin of the *infraspinatus* (Plate 5, fig. 6, *h*) is underneath that of spino-deltoideus, from the whole length of the infraspinous fossa, except at the gleno-vertebral angle, where it meets and partly unites by a raphe, with the teres. Its tendon inserts on the trochiter, adjacent to that of the supraspinatus, but slightly distal to it.

The peculiar relations of the *epitrochlearis* (Plate 5, fig. 5, *d*) have been described by Dobson in *Solenodon cubanus* and they are the same in *S. paradoxus*. This muscle arises from a raphe about 18 mm. long, from the commencement of the tendinous portion of the latissimus dorsi. It is also connected at this point by a few fibers from the teres. The insertion is at the olecranon.

The *micostalis* (Plate 5, fig. 6, *a*) or "teres minor" is a small muscle, intimately associated with the infraspinatus. Its origin is from the glenoid border of the scapula, back about 11 mm. along the glenoid margin. Its insertion is by a very short tendon just distal to the insertion of the infraspinatus on the trochiter. According to Dobson, this muscle is lacking in Centetes, Gymnura, and Potamogale. It is present, however, in Erinaceus and largely developed in Myogale.

The *meditriceps* (Plate 5, fig. 6, *b*) is a large, prism-shaped muscle, from nearly the anterior third of the glenoid margin of the scapula. It tapers distally to a short tendon inserted on the olecranon.

The *ectotriceps* (Plate 5, fig. 6, *c*) arises from a sheet of tendon on the proximal part of the crista deltoidea. It is a flat muscle and gradually increases in breadth to its insertion on the ectal face of the olecranon, anterior to that of the meditriceps, to whose tendons for the space of about a centimeter it is here intimately connected.

The *entotriceps* (Plate 5, fig. 6) is divisible into three fairly distinct parts. The first of these seems comparable with the intermedia and the caudalis divisions as present in the cat. In Solenodon these two divisions are not to be differentiated, but arise as a single muscle from the posterior side of the humerus just distal to its head. The insertion is by tendon on the entero-dorsal side of the olecranon as far as the sigmoid notch. A second division, probably homologous with the division cephalica of the cat, arises along the postero-external side of the distal half of the humerus and inserts on the ectal aspect of the olecranon, ental to the insertion of the ectotriceps. The third division is apparently the same as the division brevis, and consists of a short bundle of muscular fibers from the ectal surface of the epitrochlea to a tendinous raphe near the distal extremity of the division cephalica. The condition of the triceps muscle in Solenodon seems to be much the same as that described by Dobson for Gymnura, and one is led to infer that its relations are nearly identical in Centetes and Potamogale.

The *supinator longus* is absent in Solenodon, as in Gymnura, Erinaceus, Centetes, Potamogale, and the Talpidae.

The *biceps* arises by a single head, as a strong rounded tendon about a centimeter in length from the dorsal lip of the glenoid fossa and base of the coracoid process. Its main mass is spindle-shaped and flattened. Distally it passes into a tendon that is inserted mainly on to the ecto-dorsal edge of the ulna, just distal to the lip of the sigmoid notch; a slip of tendinous tissue also connects

it with the proximal end of the radius at the point where radius and ulna meet at the articulation with the humerus. This is the condition likewise in Centetes, and practically that found in Gymnura, where, however, only the ulnar insertion is described. In Dobson's specimen of *Solenodon cubanus* he found *two* heads to this muscle. The second he describes as "a long and very slender tendon from the coracoid process immediately above that of the *coraco-brachialis*." This, he states, "becomes muscular low down, and unites with the belly of the glenoid head about the commencement of the lower third of the humerus; the muscle thus formed terminates in a tendon which is mainly inserted into the radius." Possibly the double origin of the biceps in his specimen was an individual anomaly, or the condition in the Cuban species is different from that obtaining in *S. paradoxus*.

The *brachialis* does not differ essentially from that of Gymnura and Centetes. It arises from the posterior side of the humerus between the two tuberosities and along the ectal margin of the crista deltoidea to insert into the capsular ligament and the inner dorsal edge of the radius.

The *extensores (carpi) radialis longior et brevior* (Plate 6, fig. 5, *b*) are not separate muscles, but form a single rather flat muscle that originates from the antero-proximal portion of the epicondylar ridge. At about the beginning of the distal third of the radius this muscle becomes a thick tendon that passes ental to that of the extensor ossis metacarpi pollicis, and splits into two tendons that go to the bases of metacarpals 2 and 3 respectively.

The *extensor digitorum communis* (Plate 6, fig. 5, *a*) arises by tendinous fibers from the ectal point of the epicondylus. Near the distal end of the radius it passes into a flat tendon that breaks directly into four small branches, one each to the dorsal surface of digits 2 to 5.

Just distal to the origin of the last, arises the *extensor minini digiti* (Plate 6, fig. 5, *g*) from the ectal edge of the epicondylus and from tendinous fibers from the communis and the extensor carpi ulnaris. It passes into a strong tendon that divides into two branches at the metacarpals. The ectal branch passes to the dorsal side of digit 5 and the ental branch dips under the outermost division of the communis to insert on the ecto-lateral face of the last phalanx of digit 4. This condition is essentially that in Centetes.

The *extensor carpi ulnaris* (Plate 6, fig. 5, *e*) arises just distal to the origin of the preceding, at the outer distal edge of the epicondylus and from fibers along the greater sigmoid notch. At about 18 mm. from its insertion it becomes a thick round tendon, passing to the ecto-proximal margin of metacarpal 5.

In Centetes and Erinaceus this muscle is said to be inserted into a sesamoid at the base of metacarpal 5.

The *indicator* (Plate 6, fig. 5, *f*) arises from an origin about 25 mm. long by muscular fibers along the ectal border of the ulna beginning near the distal edge of the sigmoid notch. The muscle then passes across to the ental aspect of the forearm, through the groove between the distal ends of the radius and ulna as a flat narrow tendon. At the carpal region the tendon divides into two, the more ental of which passes to a tendinous insertion about the dorsal base of the first phalanx of digit 1; the more ectal branch goes to a similar insertion on the ecto-lateral aspect of the first phalanx of digit 2. A similar condition is found in Erinaceus and Centetes.

The *extensor ossis metacarpi pollicis* (Plate 6, fig. 5, *d*) arises by muscular fibers along the approximated edges of radius and ulna from the region of the greater sigmoid notch, distally to within 5 mm. of the carpus on the ulna and to within about twice that distance on the radius. It then passes as a tendinous band, obliquely over the distal surface of the radius to the base of an elongated sesamoid bone on the ental side of the carpus, and to the ento-lateral aspect of the base of the first metacarpal. The relations of this muscle are said to be the same in Centetes.

The *pronator teres* (Plate 6, fig. 5, *c*) has its origin by short tendinous fibers from the epitrochlea and passes ectally as a flat sheet to a long tendinous insertion on about the middle third of the dorsal edge of the proximal portion of the radius.

The *flexor carpi radialis* (Plate 6, fig. 6, *b*) is from the anterior border of the epitrochlea, arising by tendinous fibers as a long, spindle-shaped muscle. This passes into a round tendon whose insertion is at the ventral ental side of the base of metacarpal 3. Dobson does not mention this muscle in Centetes, but states that in Erinaceus and Potamogale it goes to the base of the second metacarpal. Its condition in *Solenodon paradoxus* is thus more nearly that found in the cat, in which a small branch passes also to the first metacarpal.

The *flexor carpi ulnaris* (Plate 6, fig. 6, *c*) arises from the internal condyle of the humerus and is inserted by a strong tendon into the pisiform bone as in Erinaceus, Potamogale, and Centetes.

The *flexor sublimis digitorum* (Plate 6, fig. 6, *a*) is a narrow flat muscle whose origin is wedged in between the heads of the flexor profundus digitorum. It arises as a flat tendon about 12 mm. long from the anterior surface of the epitrochlea, about one or two millimeters from the ental margin. The muscular

portion becomes trifid distally, and each division sends a tendon to the second, third, and forth digits respectively. This tendon bridges the groove of the profundus.

The *flexor profundus digitorum* (Plate 6, fig. 6, *d*) arises as in Gymnura and Centetes from five heads, and thus differs from that of Potamogale in which but three are described. The first of these heads is superficial, from the anterior edge of the epitrochlea; its large tendon inserts into the common tendon on the radial side at the wrist. This division is more or less distinct throughout its distal union with the main mass of the tendon and has been homologized by Dobson with the *flexor longus pollicis*. Two smaller muscles, forming the second and third heads, arise in close association from the anterior surface of the epitrochlea and the anterior edge of the great sigmoid notch. Their tendons become confluent and join the main palmar tendon medially proximal to the insertion of the first division. The head of flexor sublimis separates the head of the first division from the common origin of the second and third. The fourth head arises as a large fleshy muscle along the ectal side of the ulna from the olecranon to within about 15 mm. of the distal end of the ulna where its fibers merge with those from the fifth division whose origin is from the proximal two thirds of the ental border of the radius. These five divisions unite to form a thick flat tendon at the wrist. This divides at the base of the metacarpals to form the usual five branches, one to the lower surface of each digit. This muscle in Solenodon seems most nearly to resemble that of Gymnura in possessing five distinct heads. In Centetes the condition is essentially similar, but the closely associated second and third heads are united into a single division. In Potamogale the number of heads seems to be still further reduced.

MUSCLES OF THE HIND LIMB.

The *psoas magnus* (Plate 4, fig. 2, *o*) appears to be essentially similar in its relations to that of Gymnura, Erinaceus, and Centetes. It arises from the transverse processes of the lumbar vertebrae as a thick muscular mass and becomes confluent with the iliacus from the ventral side of the anterior ramus of the ilium. It then tapers to its insertion on the lesser trochanter of the femur.

The *psoas parvus* (Plate 4, fig. 2, *p*) arises as a flat ellipsoidal muscle from the ventro-lateral portion of the first lumbar and the anterior portion of the second lumbar vertebrae. It then passes posteriorly as a thin flat tendon from 2 to 3 mm. wide and 30 mm. long to insert on the anterior edge of the pelvis, just

anterior to the origin of the pectineus. This muscle is thus closely similar to that of Erinaceus, Centetes, and Myogale, having apparently much the same proportions, origin, and attachment. In Potamogale and Gymnura it is very much larger in relative size and extent of origin, and is remarkable in the latter on account of its insertion upon the lesser trochanter together with the psoas magnus.

The *gluteus maximus* (Plate 6, fig. 1, *e*) arises as a thin muscular sheet by tendinous fibers along the dorsal border of the ilium and the dorsal spines from the fourth lumbar to the first caudal vertebra. A very distinct and separate portion of this muscle (Plate 6, fig. 1, *m*) arises from the anterior tuberosity of the ilium, just back of its dorso-lateral edge and passes postero-ventrally to join the anterior edge of the main mass of the maximus about a centimeter dorsal to the common tendinous insertion into the prominent crest below the great trochanter and some 15 mm. from the head of the femur. This peculiar second head may be an anomaly. Dobson does not mention it in his account of the muscles of *Solenodon cubanus*. In Gymnura the gluteus maximus is described as having a continuous origin "from the whole anterior margin of the ilium," a condition from which that in Solenodon just described might readily be derived.

The *gluteus medius* (Plate 6, fig. 1, *b*, *n*) arises as in Gymnura, Erinaceus, and apparently Centetes, from two heads, here, however, with difficulty distinguishable, from the entire outer face of the anterior portion of the ilium as far back as the level of the third sacral vertebra. The more anterior part is thick and fleshy; it inserts by tendon on the antero-dorsal portion of the great trochanter. The more posterior division inserts somewhat more distally on the posterior part of the great trochanter. The great sciatic nerve takes exit at the hinder margin of the first part of this muscle and is slightly overlapped by the second.

The *gluteus minimus* (Plate 6, fig. 1, *a*) is small and flat, from an origin about 14 mm. in length on the ischium beginning just above the acetabulum. It is inserted by tendinous fibers on the great trochanter, entero-posteriorly to the two other glutei. This muscle agrees with that of Gymnura in its more posterior origin; in Erinaceus it arises from the ilium.

The *rectus femoris* (Plate 6, fig. 1, *l*) is from a short tendinous origin some 4 mm. long from the postero-ventral margin of the ilium just anterior to the acetabulum. It is inserted on the antero-internal edge of the patella.

The *vastus externus* (Plate 6, fig. 1, *k*) has a long origin from the great trochanter and the trochantal ridge nearly to the distal end of the femur, and

passes into a tendinous insertion on the ectal side of the dorsal margin of the patella.

The *cruveus* (Plate 6, fig. 1, *j*) arises along the anterior margin of the femur and is almost inseparably united to the vastus externus. It inserts medially on the patella beneath the insertions of the vastus externus and the rectus femoris.

The *vastus internus* (Plate 4, fig. 2, *b*) is distinct, instead of being fused with the crureus as in Gymnura. Its origin is from the antero-ental side of the proximal third of the femur, and its insertion is at the ento-dorsal corner of the patella.

The *pectineus* (Plate 4, fig. 2, *n*) is a thick muscle somewhat triangular in section. Its origin is just dorsal to that of the adductor longus for about 9 mm. on the anterior rim of the pelvis and posteriorly nearly to the acetabulum. It is visible superficially for but a slight space, and passes beneath the surrounding muscles to its insertion as a somewhat tendinous sheet on the inner posterior length of the femur from the lesser trochanter nearly to the distal head. It is thus slightly more developed than in Gymnura.

The *quadratus femoris* (Plate 4, fig. 2, *h*) is large, from an origin 19 mm. long on the posterior edge of the ischial tuberosity, covered by the adductor magnus and the semitendinous. It is inserted by a tendon on the lesser trochanter and the intertrochanteric fossa. Its relations are closely similar to those in Potamogale and Centetes. No connection with adductor brevis was found such as is described for Gymnura.

The *obturator externus* arises from the membrane covering the obturator foramen and from the bone bordering it. The insertion is by tendon into the trochanteric fossa posterior and ental to the great trochanter. This muscle is essentially similar to that of Gymnura, Centetes, Potamogale.

As pointed out by Dobson, Solenodon differs from Centetes and agrees with Gymnura, Potamogale, Erinaceus, and Myogale in the absence of an *obturator internus*.

The *gracilis* (Plate 4, fig. 2, *g*) is large and arises from the dorsal half of the posterior margin of the ischium. It is somewhat pyramidal at first, becoming a flat muscular sheet just below the head of the tibia along its antero-internal border. As noted by Dobson, the gracilis muscles of the two sides of the body are well separated in Solenodon and related genera, but united medially in Centetes. No accessorius portion of this muscle was observed.

The *biceps femoris* (Plate 6, fig. 1, *i*) is from two heads. Of these, the larger is from the ischial tuberosity, while the smaller consists of a flat tendinous mem-

brane from the spines of the two first caudal vertebrae. The two branches shortly unite to form a broad thin tendinous sheet that inserts on the ectal portion of the head of the tibia and condyle of the femur. Its condition is thus practically as in Gymnura. In Centetes and Potamogale the insertion is upon the fibula.

The *semitendinosus* (Plate **6**, fig. 1, *d*) arises in a somewhat similar way by two heads: one by tendinous fibers from the dorsal spines just posterior to the origin of the dorsal branch of the biceps; the other from the tuberosity of the ischium posterior to the biceps. These two heads unite to form a single sheet of muscle that passes to an insertion some 9 mm. in length on the antero-ental side of the tibia, 22 mm. below its head. It resembles the same muscle in Centetes, Potamogale, and Myogale, rather than in Gymnura.

The *semimembranosus* (Plate **4**, fig. 2, *d*) is very large and divisible into two portions. The first is a narrow band from the postero-ventral portion of the tuberosity of the ischium, passing to an insertion on the inner distal tuberosity of the femur. The second portion is the larger, and arises from the entire posterior border of the pelvis. It is inserted by short tendinous fibers on the ental aspect of the tibia for a distance of 11 mm. from its proximal head. This muscle is essentially like that of Centetes in its attachments. In Gymnura and Potamogale it is less extensive in origin and has but one head.

The *sartorius* is absent, as also in Centetes and Potamogale according to Dobson, who found it feebly represented, however, in Gymnura. Leche (**:02**) considers this muscle well developed in the last named.

The four adductores are well developed and quite separate. The *adductor longus* (Plate **4**, fig. 2, *c*) is a rather narrow band, arising from the anterior edge of the pubis, just ventral to the origin of the pectineus. It inserts as a tendinous sheet on the ental surface of the inner condyle of the femur. Dobson describes in *Solenodon cubanus* a second small slip passing to the femur at the middle third of the shaft, but no such part was found in *S. paradoxus*, which therefore resembles Potamogale in respect to this muscle. In Gymnura and Centetes, however, Dobson describes a long insertion nearly the whole length of the femur, so that the condition he describes in *S. cubanus* is intermediate between that of Gymnura and Centetes on the one hand, and *S. paradoxus* and Potamogale on the other.

The *adductor brevis* (Plate **4**, fig. 2, *e*) arises under cover of the gracilis from the ventral portion of the pubis and ischium. It is inserted by tendinous fibers for a distance of about 10 mm. along the distal third quarter of the femur on its

posterior side. This muscle in Centetes is similar but with a rather more extensive distal insertion, while in Gymnura the insertion is nearer the proximal end of the femur.

The *adductor magnus* (Plate 4, fig. 2, *m*) is small. It is a thin narrow strip arising from the tuberosity of the ischium under the biceps, and passes to an insertion under cover of that of the adductor longus on the internal condyle of the femur. This muscle shows a less developed condition as compared with that of Gymnura and Centetes. The peculiar insertion into the inner head of the gastrocnemius described by Dobson in Potamogale, he believes is a special modification correlated with the animal's habit of drawing the hind leg up against the tail when swimming.

The origin of *adductor quartus* (Plate 4, fig. 2, *k*) is under cover of that of adductor brevis from the ventral portion of the pubis and ischium, but its posterior extent is less at the ventral margin. It increases slightly in breadth as it passes over the lesser trochanter to insert on the proximal third of the femur along the ento-posterior side of the great trochantal ridge nearly to the proximal insertion of the adductor brevis. In Centetes and Potamogale according to Dobson, this muscle presents the same relations, but it appears to be absent in Gymnura.

The *gastrocnemius* (Plate 6, fig. 1, *e*; fig. 4) is a large muscle arising by two heads as usual. The first is from the posterior side of the external condyle of the humerus, by a stout tendon in which there is a small sesamoid bone; the second is from the internal condyle just proximal to the insertion of a portion of the semimembranosus to which it is joined by a few fibers. The great nerve trunk of the leg passes between these two heads. The insertion is as usual by the tendon of Achilles into the calcaneum at its posterior end.

The *soleus* (Plate 6, fig. 4, *a*) shows an interesting relation, and one apparently not observed by Dobson in *Solenodon cubanus*. It arises by tendinous fibers from the ecto-posterior edge of the head of the fibula, and becomes fused with the ectal portion of the gastrocnemius above its passage into the tendon of Achilles. A similar condition is found in Gymnura and Potamogale, but apparently not in Centetes.

The *plantaris* resembles that of Centetes in being inseparable from the gastrocnemius at its origin. Its tendon is apparent, however, on the ento-lateral side of the gastrocnemius. In Gymnura and Potamogale the origin is described as distinct from that of the latter.

The *popliteus* arises as usual from the thick tendon investing the ectal side

of the condyle of the femur. It passes obliquely as a triangular muscle to insert upon the postero-ental surface of the tibia just proximal to the origin of the tibialis posticus. There is a large sesamoid in the tendon of origin, attached by fibers between the heads of tibia and fibula.

The *tibialis anticus* (Plate 6, fig. 1, *h*) arises from the large shallow fossa on the ectal side of the tibia and the adjacent portion of the fibula. The muscle is triangular in section and becomes a strong flat tendon distally, that passes to the ental side of the foot through the same loop as the extensor longus digitorum. It is inserted on the ento-lateral side of the base of the entocuneiform bone, not on the rudimentary first metatarsal as in some mammals, *e. g.*, the cat, or the metatarsal of the first digit as in Gymnura, Potamogale, and apparently Centetes. Dobson does not mention the connections of this muscle in *Solenodon cubanus*. In *S. paradoxus*, however, this termination was carefully verified on both hind feet. The inserting tendon is large and conspicuous and is inserted back from the anterior edge of the bone.

The *extensor longus digitorum pedis* (Plate 6, fig. 1, *g*) is a very small narrow muscle, hardly 2 mm. in radial thickness, and less than that in superficial breadth. Its origin is from the tendinous sheath covering the ectal aspect of the condyle of the femur. Its tendon passes through a loop on the anterior part of the ankle together with the tendon of the tibialis anticus, then through a second loop enclosing the extensor alone, which here has broken into four appressed thread-like branches, one to each of the digits, 2, 3, 4, and 5. The branch to digit 5 is inserted at the ental, the others on the dorsal aspect of their respective digits. A similar arrangement is described for Gymnura and Centetes.

The *peroneus longus* (Plate 6, fig. 1, *f*) is very distinctly from two heads. The first is from the tendinous sheath covering the external condyle of the femur, continuous with the origin of the extensor longus digitorum. These tendinous fibers pass across to the second and principal origin about the head of the fibula. At a little more than one half the length of the tibia the muscle passes into a slender tendon, which dips under a loop at the ectal side of the ankle, then under a second loop on a prominence at the ecto-anterior portion of the calcaneum. It then gives off a small branch to the base of metatarsal 5 and continues across the foot to the insertion into the base of metatarsal 1. In Gymnura and *Erinaceus europaeus* it is merely inserted into the internal cuneiform, but in *E. jerdoni* according to Dobson ('82–'90, p. 55) the branch to the fifth metatarsal is also present. The insertion into the first metatarsal seems

to be a peculiarity not hitherto noted, but was unmistakably present in *S. paradoxus* and may be anomalous.

The *peroneus brevis* and the *peroneus quinti digiti* arise on the antero-external aspect of the fibula, the latter from the external aspect for a distance of about 11 mm. distal from the head, and the former more internal, for a slightly greater distance. The tendons of both are invested in a common sheath and pass together posterior to the external malleolus and beneath the tendon of peroneus longus. Peroneus quinti digiti is inserted into the distal phalanx of digit 5, while the peroneus brevis passes to the ecto-proximal end of the fifth metatarsal. Both these tendons are simple and show no trace of secondary divisions to digit 4 as described for Gymnura and Centetes by Dobson. Solenodon thus resembles Potamogale in the single attachments of these muscles.

The *extensor hallucis longus* arises from the middle third of the fibula and adjacent interosseus ligament and passes to the distal phalanx of digit 1 on the dorsal side, through the same large groove on the front of the ankle, as the extensor longus digitorum and the tibialis anticus.

The *tibialis posticus* (Plate **4**, fig. 2, *j*) is concealed by the flexor longus digitorum. It arises from the proximal end of the fibula on its posterior side and is more or less connected by muscular fibers with the flexor longus hallucis. After crossing to the ental aspect of the limb, it passes as a small tendon through a groove on the distal part of the tibia to the insertion into the ento-lateral process of the os calcis at its anterior end, not into the naviculare or scaphoid as commonly. Dobson states that this muscle in *Solenodon cubanus* retains its usual insertion into the naviculare, but in *S. paradoxus* it was found on each side, inserted unequivocally as above noted.

The *flexor longus digitorum*, or *digitorum tibialis* (Plate **4**, fig. 2, *l*) arises mainly from the posterior proximal portion of the tibia. The tendon passes through the same groove on the ental aspect of the tibia as that of the tibialis posticus, and ectal to it. It becomes inserted into the ventral surface of the flexor longus hallucis. At the base of the carpals, it gives off a small branch to the rudimentary first metatarsal. This muscle in Solenodon resembles the corresponding one in Potamogale, rather than that of Centetes whose curious development has been described by Dobson. In Gymnura it is merely united with the next.

The *flexor longus hallucis* (or *digitorum fibularis*) (Plate **4**, fig. 2, *i*) takes origin from nearly all but the distal portion of the posterior side of the fibula and adjoining middle third of the tibia. It is much larger than the flexor

digitorum tibialis. Distally it passes into a strong tendon that runs along the ventral groove of the os calcis and spreads out over the sole of the foot. Here it is joined by the tendon of the flexor longus digitorum or tibialis and then sends a large tendon to the ventral surface of each digit.

Two short stout tendons bind the foot to the bones of the lower limb. The one is from the distal end of the fibula at its ectal margin and passes to the dorsal edge of the os calcis posterior to the articulation with the astragalus. The second tendon is on the ental side from the anterior edge of the tibia to the proximal end of the naviculare.

MUSCLES OF THE TAIL.

The tail of Solenodon is capable of almost no lateral movement, but may be slightly elevated and depressed. In section it is nearly quadrangular proximally after the skin has been removed to expose the muscle masses. These are chiefly four.

The *levator caudae internus* is the most dorsal, and is continuous with the semispinalis of the back. It passes dorsal to the metapophyses, and breaks into tendinous threads that form a distinct bundle running the length of the dorsal side of the tail. On the distal two thirds of the tail these tendons become inserted on the anterior zygapophyses. This mass of fibers is joined by small tendons from muscles that arise from the metapophyses of the caudal vertebrae and by others from the dorsal portion of the vertebrae between the spines and the zygapophyses. The tendinous bundle resulting from these fibers, tapers to the extremity of the tail and forms the dorso-lateral angle of the tail.

The *levator caudae externus* is smaller. It is a bundle of small muscles that arise by tendons from the median edge of the anterior portion of the ilium and from the metapophyses of the sacrum. These unite and pass distally as a thin lateral bundle connecting the metapophyses of the caudal vertebrae.

The ventral musculature of the tail is mainly from the *sacro-coccygei*, one on either side of the mid-ventral line, below the metapophyses. These arise each as an elongated mass from the ventral side of the sacral vertebrae, medially. Just distal to the ischium they pass into strong tendinous strands that shortly form a rounded compact bundle, tapering to the distal end of the tail. This bundle forms the ventro-lateral angle of the tail on each side as seen in section, and fills the space between the chevron bones and the metapophyses.

Ventrally a small muscle arises from the posterior end of each chevron bone

on either side. It passes externally to the next posterior chevron bone as a small tendon and inserts into the antero-ventral end of the chevron bone next succeeding. Each muscle therefore skips one chevron bone and inserts upon the next but one posterior to its origin.

OSTEOLOGY.[1]

The cranial characters of Solenodon are now well known. The original skull described and figured by Brandt ('**33**) was incomplete, having lost the occipital portion. In his recent paper on this animal, Dr. J. A. Allen (:**08**) has given photographic reproductions of the skulls of old and young. The superior outline of the skull is nearly flat, becoming slightly depressed posteriorly. The sagittal crest is slightly developed on the posterior half of the skull but in the specimens examined was barely over a millimeter in greatest extent vertically over the condyles. The lambdoid crests are greatly developed and overhang the foramen magnum about 5 mm. The maxillary region increases gradually in depth from behind the large first incisors to the molars, where it abruptly deepens to the last molar. This depth is retained to the mastoid region, then becomes slightly less. The lachrymal foramen is very large, and only 2 mm. dorsal to the great antorbital foramen. There are several (4 or 5) small foramina above the mastoid process for the passage of vessels. In dorsal aspect, the most striking peculiarities of the skull are: the deep emargination of the nasals, with their median point some 4 mm. posterior to the anterior end of the intermaxillaries; the long, parallel-sided snout, occupying slightly more than one third the length of the skull; the elongated brain-case, slightly contracted at the middle of the orbit, then expanding at the mastoid region and ending in a parallel-sided and abruptly truncated occiput. There is a diastema between the first and second incisors, at which point is a depression on each side in the floor of the palate. The two incisive foramina are at the medial border of each pit, and measure 2 mm. in length. The palate is nearly parallel-sided on the rostral portion, and expands distally. Minute foramina occur at the ental bases of the teeth and posteriorly near the median region but otherwise the palate is entire in our specimen. The interpterygoid fossa is deep, and slightly convergent posteriorly, thus differing from that of *S. cubanus* in which these walls diverge. The hamular processes of the pterygoids are short but sharply con-

[1] Since this account was prepared, W. K. Gregory has published a description of the skeleton of *S. paradoxus* (see Bull. Amer. mus. nat. hist., 1910, **27**, p. 241–255).

vergent. A small projection of the palate forms a minute tooth medially at the posterior edge of the palate. The tympanic bone is a nearly complete narrow ring, not fused with the mastoid portion of the periotic, but meeting it for a space of about 3 mm. along the ecto-posterior edge. At the antero-lateral termination of the tympanic is the large fissura Glaseri as a groove on the posterior side of the post-glenoid process. There are two large foramina between the ental end of the latter and the pterygoids, the more anterior of which appears to correspond to the foramen rotundus and the more posterior, which is slightly the larger, to the foramen ovale. The zygomata are incomplete. The round flat bone, fastened by ligament to the anterior end of the intermaxillaries at the ventral edge of the nasal cavity was noted and described by Brandt in his paper of 1833. It serves to support the base of the cartilaginous proboscis and was termed by Brandt the os proboscidis. It is lacking in *Solenodon cubanus*. It is nearly circular and about 5 mm. in diameter in our specimen.

The teeth have been thoroughly described by Brandt, Peters, Dobson, Leche, and more recently by J. A. Allen, who has figured the milk dentition. The tooth formula is $I\frac{3}{3}\ C\frac{1}{1}\ P\frac{3}{3}\ M\frac{3}{3}$. In addition to the smaller size of the teeth, those of the Cuban species differ conspicuously in the presence of a diastema nearly 2 mm. long between the third upper incisor and the canine; in the absence of an anterior cingulum cusp on the upper canine; and in the form of the second upper premolar, which in the Cuban animal has a prominent ento-posterior angle giving a nearly triangular basal section to that tooth, whereas in *Solenodon paradoxus* this angle is not developed and the tooth is nearly oval in outline. All the teeth of the lower jaw are in contact in both species. The last lower molar of *S. paradoxus* shows a slightly greater relative development of the posterior cusp than that of *S. cubanus*. The remarkable resemblance in the form of the skull and teeth of Solenodon to those of Myogale was noted by Brandt. The general resemblance in external form as well, suggests that in these respects Myogale is a generalized member of the Talpidae that has acquired a further development of the molariform teeth from the primitive tritubercular condition of the crowns to the more specialized W-shaped type of crown. In these respects and in certain points of muscular development, Myogale probably stands in much the same relation to the rest of the Talpidae as does Gymnura to the others of the Erinaceidae. Both are generalized forms bearing many close resemblances to the more primitive Solenodontidae.

The remarkable deep groove of the large second lower incisor of Solenodon seems peculiar to this genus. In Erinaceus there is a shallow groove on the first

incisor at the internal side of the tip and a similar condition exists in the second lower incisor of Talpa.

The vertebrae of *Solenodon paradoxus* are: cervicals, 7; dorsals, 16; lumbars, 4; sacrals, 4; caudals, 24; total, 55. There is thus one more dorsal, one less sacral, and one less caudal than described for *S. cubanus* by Peters, whose account appears to be the only one on which our knowledge of the skeletal parts of *S. cubanus* other than the skull, is based. Dobson apparently follows Peters, though he states that his description of the myology is based on the dissection of a specimen from Cuba in the Paris Museum. Peters's figure is very clear, and the additional sacral vertebra in *cubanus* seems to be a caudal fused to the sacrum since the first chevron bone is between this fused vertebra and the next following caudal vertebra instead of between the first and second free vertebrae. In possessing 16 dorsals, *Solenodon paradoxus* resembles Potamogale. Gymnura has 15, as does *S. cubanus*, and certain species of Erinaceus. Centetes seems still more primitive in possessing 19, as does Chrysochloris. The lumbar vertebrae in Solenodon are reduced in number as in the latter genus, being but 4, and thus fewer than in the other generalized Insectivora. Centetes is remarkable in possessing but two sacrals, though *Solenodon paradoxus* with four only shows a reduced condition as compared with related genera. The following table will show at a glance these differences.

Vertebral Formulae of Insectivora.

	Cervicals.	Dorsals.	Lumbars.	Sacrals.	Caudals.
Gymnura alba	7	15	5	5	25
Erinaceus	7	14–15	6	7	6+
Talpa	7	13	6	5	12
Myogale	7	13	6	6	27
Potamogale	7	16	5	5	32
Centetes	7	19	5	2	7
Solenodon cubanus	7	15	4	5?	23?
Solenodon paradoxus	7	16	4	4	24
Chrysochloris	7	19	4	5	8–9

The atlas of Solenodon (Plate 7, figs. 4, 5) resembles that of Gymnura in possessing a ventral median hypapophysis extending posteriorly from the anterior lip, but the remaining vertebrae are without hypapophyses, thus differing from Gymnura and Potamogale. The axis is large with a high broad crest and elongated transverse processes at its ventral margin, directed posteriorly (Plate 7, figs. 8, 9). At the fourth cervical vertebra the transverse process has also an anterior projection which increases somewhat in the two succeeding.

In the 6th vertebra this process is produced axially forming a broad ventrolateral ridge extending posteriorly beyond the edge of the vertebra itself. This condition is found in *Gymnura alba* of which a skeleton was examined. In Erinaceus the posterior extent of this process is less. In the seventh cervical this large process is normally obsolescent, but in one example of *Solenodon paradoxus* examined, it is equally divided between the 6th and the 7th cervicals so that a vertebral canal is abnormally present on the left side of the 7th cervical, but not on the right side.

The dorsal vertebrae in a general way resemble closely those of Gymnura. The spines of the three first dorsals increase successively in height, and measure from the anterior end of their proper bases, 11.5, 16, and 17 mm. respectively. These spines are high and somewhat circular in section, and expanded a trifle distally. In Gymnura the spine of the second dorsal is highest. The following spines from the fourth to the ninth decrease slightly in height, and become stouter and laterally compressed. All of the series are directed sharply backward. The spines of the tenth, eleventh, and twelfth vertebrae, however, are hardly tapered distally and curve distinctly forward at their tips. The thirteenth spine is nearly upright and the fourteenth is almost twice its length and points anteriorly. The two last dorsals have low spines whose tops are flat in profile and nearly as long as their centra.

The twelfth dorsal vertebra begins to develop a descending lateral point at the posterior end, that becomes a distinct diapophysis at the 14th vertebra and in the vertebrae succeeding. Beginning with the first lumbar (Plate 7, figs. 13, 14) however, the diapophysis instead of being directed posteriorly, is curved anteriorly from a base running the length of the vertebra on a level with the center of the spinal cord.

The four sacral vertebrae are solidly fused throughout, much as in Gymnura, and the continuation of the diapophyses forms a flange or shelf along the sides of the centra. The dorsal profile is slightly emarginate between successive spines of the fused vertebrae. The sacrum, in dorsal view is narrower near the middle of its length than at either end.

The caudal vertebrae (Plate 8, figs. 3, 4, 6) rapidly lose their dorsal spines, which are well developed in only the three first. The neural canal practically disappears with the ninth. The prezygapophyses of the fifth caudal are the last to form an articulation, for this and the succeeding vertebrae lack any trace of postzygapophyses. The prezygapophyses become successively reduced toward the tip of the tail, and become obsolete on the 16th or 17th vertebra.

At the sixth caudal the broad diapophysis is divided into an anterior and a posterior portion, the latter of which becomes obsolete at the 15th, and the former at about the 18th vertebra. In Gymnura the diapophyses are much less developed, having an anterior but not a posterior origin on each vertebra, while the prezygapophyses, in the specimen examined, end with the third caudal.

The chevron bones are largely developed, and as in Gymnura occur in connection with all but the few terminal vertebrae. In Gymnura, however, the two lateral elements of each chevron are unfused except in case of the second and third which are united at their origin medially. Their antero-posterior extent is much greater in Gymnura. In Solenodon the two lateral elements of the first chevron are thin terete spicules of bone, approximated distally but separate. The second chevron is similar but the two elements are fused both proximally and distally forming a closed canal for the caudal artery. The same condition prevails in the two following, whose distal parts are in addition expanded laterally. In all the succeeding chevron bones the arterial canal is open ventrally. The last chevron is between the 21st and the 22d caudals. In *Solenodon cubanus* Peters has figured but twenty chevron bones. There are 21 in *S. paradoxus*.

The ribs and sternum (Plate 7, figs. 11, 12) of Solenodon are remarkably strong and well ossified. The sternal portions of the first twelve ribs are bony, while the thirteenth is cartilaginous at the distal end only. The two succeeding ribs are connected by a cartilaginous strand to the ventral margin of the other sternal ribs, while the 16th rib is short and without such connection. The sternal portion of the first rib is broad at its articulation with the manubrium along the posterior curve of its antero-lateral expansion. The sternal portions of the three ribs following articulate each at the point of union of the first and second, second and third, and third and fourth sternal elements respectively The fifth rib is inserted at the junction of the fourth and fifth sternal elements, and its sternal portion is of two separately ossified pieces. The fifth sternal element serves for the attachment, directly or secondarily of ribs 6 to 14 both inclusive. The sixth and seventh ribs are inserted separately, one directly in front of the other; the latter has three bony portions ventral to the main dorsal shaft. The sternal portions of ribs 8, 9, 10, and 11, have each a proximal section about 13 mm. long, making nearly a right angle with the more distal portion running antero-internally to the sternum and forming the ventral rim of the thoracic basket. These more distal pieces of these ribs just mentioned, are fused into a single bony mass, on whose ectal surface may be traced the lines of union,

though on the ental face these lines cannot be seen. In Gymnura the sternal cartilages of but two ribs, the 8th and the 9th, are partly fused in this way. The terminal cartilages of ribs 12, 13, 14, and 15, are bound by connective tissue to the posterior rim of this large fused mass in *Solenodon paradoxus*. The extreme development of the sternal portion of the ribs in Solenodon is very remarkable and apparently not found in other Insectivora. In a skeleton of *Ericulus setosus* from Madagascar, however, a somewhat similar ossification of the sternal portions of the ribs is present, but there is not the fusion of the ventral elements in the posterior members.

The first thirteen ribs have a double articulation: by the capitellum to the point of union of the vertebra with the vertebra next preceding; and by the tuberculum to the lateral surface of the prezygapophysis. The tuberculum disappears with the fourteenth rib and the articulation is at the anterior end of the centrum of the respective vertebrae alone, not with the centra of two vertebrae.

The sternum is of six pieces. The manubrium is roundly expanded anteriorly. It is not keeled, but is slightly emarginate at the median extremity. It thus resembles that of Erinaceus and Ericulus, and differs markedly from that of Gymnura which is lozenge-shaped anteriorly, with a strong keel. The three sternal pieces following the manubrium are quadrilateral, each slightly longer than wide and narrower at the anterior end. The fifth piece is evidently a fusion of three elements, the last of which is the most reduced in width. The flat narrow terminal element (xiphisternum) is articulated to its dorsal posterior margin and bears a large oval cartilage distally.

Compared with the sternum of *Solenodon cubanus* as figured and described by Peters, that of *S. paradoxus* differs notably in possessing one less element. There are seven sternal pieces in the former and but six in the latter. This difference seems clearly to be due to the complete fusion in *S. paradoxus* of what in *S. cubanus* are the fifth and sixth pieces, so that in the former the penultimate element of the sternum gives attachment to three sets of ribs instead of but two as in the latter. The absolute length of the articulating segments of the sternum is thus some 6 mm. shorter in *S. paradoxus* than in the Cuban species, notwithstanding the greater general size of the former. A second difference is found in the shape of the xiphioid process which in *S. paradoxus* is simple, whereas in *S. cubanus* it is represented as of two lateral portions fused anteriorly.

The clavicles are large and slightly sigmoid in anterior aspect. They are united by membrane to the antero-internal extremities of the manubrium and curve, dorsal to the head of the humerus, to the dorsal edge of the tip of the acromion.

The pelvic girdle (Plate 8, figs. 1, 2) is much like that of Erinaceus in its proportions. The pubis is well developed, with a lateral crest for the attachment of muscles, and quite without the inward arching of the anterior rim so peculiarly developed in Gymnura. The symphysis is about 4 mm. long yet firm, as in Erinaceus. In Gymnura it is incomplete. The obturator foramen is large and subquadrate in outline. The ischial tuberosities are about as far apart as are those of the ilia. In absolute size the pelvis of *Solenodon paradoxus* is practically identical with that of *S. cubanus*. Leche (:07, p. 83, text fig. 77) has given a figure and description of what he believed to be "das bisher unbekannte Becken von *Sol. paradoxus*," but there can be no doubt that the bones figured (a pelvis, with sacral and four caudal vertebrae) are not those of Solenodon at all. The figures represent a pelvis larger than that of this genus, with a long symphysis pubis, oval obturator foramen, evenly rounded ischia, and caudal vertebrae of a totally different character from those found in Solenodon. Doubtless the mistake arose through some transposition of labels, for Leche himself remarks upon the astonishing characters that the specimen presents, quite different from those of all other "Insectivora lipotyphla."

The scapula (Plate 8, figs. 5, 7, 8) is subtriangular in outline, with a greater relative development of the coracoid margin than in Erinaceus. The scapula spine is broad and shelf-like but the acromion and metacromion are shorter than in Erinaceus and Gymnura, and in this respect resemble these processes in Centetes.

The humerus (Plate 8, figs. 9–11) is short and is remarkable for its great expansion distally, on each side of the articulation. The epitrochlear foramen is present as in Gymnura, Centetes, and Ericulus. This foramen is absent in Erinaceus. In the specimen of Gymnura examined, the olecranal fossa is perforate, but no such perforation was found in Solenodon, Ericulus, or Erinaceus, and it apparently does not exist in Centetes. The extreme length of the humerus is 49 mm. or about 5 mm. longer than that of *S. cubanus*; its least breadth is 5 mm. at about the commencement of the distal third of its length. The greatest distal expansion is 18.5 mm., of which the articulating surface occupies 7 mm.

The radius and ulna (Plate 8, fig. 15) are separate and practically as in the Cuban Solenodon. The former is narrow proximally with a distinct neck about 5 mm. from the articulation. Distally it is expanded and articulates with the radiale and the intermedium of the carpus. Its ectal face has a shallow longitudinal groove along the distal three fourths. Its extreme length is 41.5 mm., or about 5 mm. greater than the measurement of the same bone in Peters's

figure of *S. cubanus*. At its proximal end it is in contact with the ulna for a distance of 6 mm. along the lesser sigmoid cavity. The ulna is more slender in proportions and tapers distally. At the carpus its ental side is in contact with the radius, and it articulates with the ulnare. A deep groove commences below the sigmoid notch and runs nearly the entire length of the ectal face, becoming shallower distally. In Gymnura and Erinaceus, skeletons of which were available for direct comparison, this groove is but slightly developed. A much shallower groove is present on the ectal face of the ulna, but is barely indicated at the proximal end in the two genera just mentioned. The extreme length of the ulna is 54.5 mm., and thus but 2.5 longer than that indicated in Peters's figure, natural size, of the skeleton of *S. cubanus*.

The carpus of Solenodon (Plate 8, fig. 15) is of a very generalized character, and appears to be nearly identical in the two species of the genus. The proximal row of ossicles consists of radiale, intermedium, and ulnare, the two first of which lie side by side and articulate by their proximal faces with the radius; the ulnare is an isosceles triangle in dorsal outline, and articulates with the ulna only at its proximal side, while the base is in contact with the intermedium. The radiale has the greatest lateral extent of the three, and at its ental margin is produced as a rounded knob on the ventral side. A slight sulcus near the distal end of this projection may indicate a fused basal portion of the prepollex. The os centrale is a small compressed bone mainly in contact with the radiale but on its ectal margin touching the centrale and the third carpale. The distal row of carpals is of four bones, of which the most ectal or unciform represents as usual the fused fourth and fifth carpalia; it serves for the articulation of the fourth and fifth digits. The first, second, and third carpalia are separate bones, and give articulation to their respective metacarpals. The second metacarpal, however, has also a short articulation at the inner side of its base, with the first carpale. The prepollex is about 6 mm. long and nearly 2 mm. in greatest width; it is loosely attached by connective tissue at the base of the first digit. The pisiform bone is strongly developed at the ectal side of the carpus, and articulates with the ulnare and slightly with the distal point of the ulna.

In the generalized condition of the carpus, *Solenodon paradoxus* resembles Centetes, but is even more primitive in that it retains the radiale and the intermedium distinct instead of fused into one as in the latter. According to Dobson these two bones are fused in *S. cubanus* ("There is a scapho-lunar bone") but Peters's figure shows them as two separate ossicles. Gymnura and Potamogale in addition to the fusion of these bones, show a further reduction of the carpal elements through the loss of the os centrale.

The metacarpals and phalanges are large and strong and in relative length would be arranged in the order 3, 4, 2, 5, 1. The middle three digits are subequal, and have each three phalanges. The first and fifth digits are conspicuously shorter; the former has but two phalanges, but the latter has three. The claws are shorter in *S. paradoxus* than in *S. cubanus*. A pair of small sesamoids is present ventrally at the proximal end of the first phalanx of each digit. These as usual, form a groove for the great flexor tendon. A single median sesamoid is also present at the ventral articulation of the two terminal phalanges of each digit. In the pollex, however, it is very small.

The femur (Plate 8, figs. 12, 13) is much like that of Gymnura in shape but has a shorter shaft. Indeed, the shortness of the femur is remarkable. The lesser trochanter is about as well developed as the greater. A deep fossa occurs on the posterior side of the latter and is continuous with the broad intertrochanteric depression. A conspicuous sesamoid is present on the ectal side, at the posterior curve of the distal condyle; it lies in the ectal tendon of the gastrocnemius. The large, subquadrate patella measures 7.5 mm. in length. The greatest length from the proximal to the distal condyle of the femur is 47.5 mm.

Dobson states that in *Solenodon cubanus* the tibia and fibula are distinct, as in Centetes, Ericulus, Hemicentetes, and Tupaia although so closely approximated in the distal third that they might ankylose in aged individuals. Peters's figure also shows the two bones distinct in this species. In the adult *S. paradoxus*, however, the two are united distally for 18 mm., or about one third their length. The line of fusion is discernible, nevertheless, and a deep groove is formed between them, for the peroneus tendons. This point appears to be one of some importance, for all previous writers have emphasized the separation of tibia and fibula in Solenodon as a character possessed in common with Centetes, but not found elsewhere in the related families. It is not clear that the condition as thus described for *S. cubanus* is due to immaturity or individual variation, but certainly in adult *S. paradoxus*, the tibia and fibula are distally ankylosed as in Potamogale, except that in the latter the line of union is said to become quite obliterated with age. It should be mentioned, however, that in the skeleton of a young *S. paradoxus* examined, the tibia and fibula, though closely approximated distally are apparently separate, and in the skeletons of two fully grown though not old animals, these bones are but imperfectly fused along the line of contact. The antero-internal face of the tibia is rather flat proximally, but the crest at the ectal border of this flattened area is scarcely developed, in contrast with the condition in Gymnura in which a prominent crest projects

over a deep fossa. The fibula is of about the same absolute width as in Gymnura and articulates at its head with the ectal head of the tibia. It is therefore free proximally as, apparently, in Potamogale and Myogale, but not in Gymnura and Erinaceus. An oval sesamoid bone about 3.4 mm. in length occurs in *Solenodon paradoxus* attached by fibers to the approximated posterior edges of tibia and fibula. It lies in the popliteus muscle just below its origin from the femur. I have found no mention of such a bone in other Insectivora and it is not shown in Peters's figure of the skeleton of *S. cubanus*. The greatest length of the tibia is 63 mm., and of the fibula 58.5 mm., or almost identically the same as the corresponding bones of *S. cubanus*.

The bones of the foot (Plate 8, fig. 16), according to Dobson, are in general like those of Centetes. They also appear to be essentially similar to those of the Erinaceidae. There is, however, a remarkable development of the proximal portion of the entocuneiforme, whose ventral border is continued posteriorly so as to meet the antero-internal edge of the os calcis. This portion also articulates dorsally with the ental surface of the astragalus and passes ventral to the naviculare which thus rests partly upon it. The last-named is small and trapezoidal in shape, articulating with part of the distal face of the astragalus. The mesocuneiforme is about half the size of the ectocuneiforme and the two articulate with the second and third metatarsals respectively, as usual. The cuboid is large, and its expanded proximal end articulates with the os calcis. The fourth metatarsal is supported by its distal end, as likewise the ental corner of the fifth, which rests in part on the base of the former. There is a well developed prehallux of two separate bones. The more proximal is small and nearly round, about 1.5 mm. in diameter, at the ento-posterior edge of the naviculare. The more distal bone is flattened, about 5.5 mm. long, and slightly less than 2 mm. distally where it reaches its greatest breadth. Peters has figured a similar prehallux for the Cuban Solenodon.

The metatarsal of the hallux has a ventral outer projection at the base, that partially overlaps the base of the second metatarsal from the plantar aspect. A much less imbrication is shown by the base of the second and the fifth metatarsals. No such development was noted in Gymnura and Erinaceus.

The three middle digits, 2, 3, 4, are subequal in length; the fifth is shorter, and the first a trifle shorter still. This last has two phalanges, like the pollex. As in the manus, there are two small sesamoids at the base of all the proximal phalanges, and a minute median sesamoid ventrally at the last joint of each digit.

It remains to describe briefly the laryngeal and hyoid bones (Plate 7, fig. 3).

These appear to be similar to those of *S. cubanus* as figured by Peters ('64, Plate 2, fig. 11), and are well ossified. The thyroid is the largest, 13 mm. in greatest length. It is slightly more than half a complete ring and has at the anterior dorsal margin on each side a process for the articulation with the tips of the thyrohyals. Posteriorly, the dorsal margin is similarly produced to form processes articulating with the postero-lateral margin of the cricoid. A low ridge arises about midway of the straight dorsal border and curves ventrally to the posterior edge. Above it on each side is a minute foramen at the dorsal edge of the bone. On the left side in our specimen there is in addition a minute foramen about 2 mm. anterior to the first. The thyrohyal of each side has fused ventrally with the basihyal so that the three bones thus form a half ring, bowed back at first, then forward at the ventral side. The ceratohyals are appressed against the ventro-lateral margin of this ring. They are rather thick and about 4 mm. in dorso-ventral length. Their dorsal border, and the edge of the thyrohyal adjacent, articulate on each side with the epihyal, a broad but laterally flattened bone, that projects anteriorly from this articulation. This in turn joins with the stylohyal, which is about 2 mm. longer, and much more rounded and slender. It joins the skull by a very short bony process that projects at nearly right angles from its proximal end. This process may represent a fused tympanohyal. The cricoid at its anterior end is clasped by the converging posterior processes of the thyroid and is a complete bony ring, with a postero-dorsal extension. The vocal cords are attached by cartilage, one at each side from the anterior apex of this ring to its mid-ventral line, and pass forward as a delicate strand to a median attachment just back of the anterior edge of the thyroid. The first tracheal ring is the broadest and fits into the posterior end of the cricoid, to which it is bound by muscle fibers. Peters states that in *Solenodon cubanus* the first nine tracheal rings are complete and that there are 21 in all. In *S. paradoxus* the number is slightly more, 22 to 29, and all are incomplete dorsally. The closest approximation is anteriorly where the two ends of the partial rings are about 2 mm. apart.

VISCERAL ANATOMY.

Digestive system.— The surface of the palate is marked by transverse folds whose number seems commonly to be eight, omitting the ridge bounding the posterior end. The first is a short transverse ridge between the third incisors; the second is larger and passes across at about the middle of the canines; the

third begins at the anterior corner of the first premolar on each side and is bowed forward; the fourth and the fifth arise on the palate at the base of the second and third premolars respectively; finally, the sixth, seventh, and eighth join the anterior edges of the first, second, and third molars respectively. The amount of bowing forward varies slightly. Brandt, in his original account figures but seven, and Dr. J. A. Allen has recently described the same number in the specimen at New York. These may represent actual variations or, as seems probable, one of the folds may have become relaxed and thus have disappeared through partial maceration. It is the smallest and anteriormost fold that is lacking in Dr. Allen's specimen. Peters figures nine transverse folds for *S. cubanus*.

The tongue (Plate 9, fig. 4) is long, narrow, and tapering. It is free at the tip for about 19 mm., and closely resembles that of the Cuban Solenodon in the character and distribution of the papillae. These are of three principal kinds: first, the fungiform papillae, that are scattered over the surface of the tongue from the muscular prominences at its root, where they are most numerous, to the tip; they are white, and either round columnar projections or expanded at the top, and project conspicuously from the surface of the tongue; secondly, the circumvallate papillae of which there are three, one circular and median, just posterior to the swellings at the root of the tongue, and two oval, one on each side and slightly in advance of the median papilla; in Gymnura there is no median circumvallate papilla; and thirdly under a lens, the surface of the tongue is seen to be thickly covered with minute pointed filiform papillae, which become larger and flattened with appressed and backwardly directed points in the region of the circumvallate papillae. There is a slight median groove at the tip of the tongue.

The epiglottis is short and cartilaginous, with a prominent median process anteriorly.

The salivary glands (Plate 5, fig. 1, *p*, *s*) are large and prominent. The parotid is the most conspicuous and lies behind the masseter muscle and the ear, with a forward prolongation nearly to the orbit in one specimen examined. Its duct is with difficulty traced from a point below the ear, forward parallel to the roof of the mouth to about opposite the first molar. The submaxillary gland consists of two portions as in Gymnura, one slightly more median, posterior to the angle of the jaw. Both are oval, smaller than the parotid, and slightly darker in color. In Centetes, this gland is in three divisions. Wharton's duct may be traced from the deeper portion of the gland near its center, forward, along the inner side of the ramus to the root of the tongue.

The digestive tract itself is very simple. The walls of the oesophagus, as it enters the stomach, are thrown into about eight longitudinal corrugations that become confluent in part with the more numerous rugae of the lining of the stomach. These latter consist of about 16 deep ridges and more numerous shallow ones, running longitudinally. They become reduced to five or six thickened folds at the pylorus, where they end.

The stomach (Plate 9, fig. 7) in its undistended condition, is subglobular and somewhat produced at the pyloric end as in Gymnura, though not to the extent figured by Dobson for Erinaceus. The cardiac portion shows no such extension as in *Erinaceus europeus*. Peters has figured the stomach of *Solenodon cubanus* as a nearly globular organ with the pylorus very near the oesophagus. This is somewhat different from its appearance in *S. paradoxus* when undistended, and may not represent its true form. The greatest length of the stomach is about 37 mm., and the cardiac breadth about 25 mm.

The small intestine merges with the large intestine so gradually that it is not possible to tell definitely where the two meet, but the thicker-walled portion following the last of the Peyer's patches is here taken to be the large intestine. The total length of the intestine from the pylorus is about 1390 mm., or nearly four and one half times the length from the tip of the nose to the anus. In Gymnura it is about six times the length of head and body. The total length of the small intestine, from the pylorus to the last Peyer's patch is 1200 mm., and the large intestine 190 mm. There is no indication of a caecum. The wall of the small intestine is seen under a lens to be thickly covered with villi which are arranged in more or less transverse zig-zag lines. There are some seven Peyer's patches. The first is oval, about 8 by 5 mm., and situated 132 mm. from the pylorus. At about 185 mm. after this are two smaller patches, one behind the other. A fourth about 14 by 8 mm., is found some 205 mm. posteriorly; a fifth after 250 mm. more, and a sixth, 11 by 5 mm. after 220 mm. The seventh and last is a large one about 1200 mm. from the pylorus.

The course of the intestine from the pylorus is back along the right body wall for about 50 mm., then across to the left side, and thence again posteriorly for some 25 mm., after which it turns ventrally and becomes much convoluted in the lower abdominal region. It then passes forward along the left side of the body and is again much convoluted below the stomach, whence the large intestine, after a short curve ("transverse colon") runs directly back along the dorsal body wall to the anus.

The structure of the liver (Plate 9, figs. 3, 10) is comparatively simple. The

organ is large and composed of three main lobes whose appearance is essentially like that in Centetes. The left lateral lobe is large and rather oval, slightly less in breadth posteriorly than anteriorly. It is without secondary divisions. The right lateral lobe is of smaller diameter and subcylindrical, consisting of two portions: the main lobe proper and the caudate division. The latter is large and of practically equal length with the main lobe into whose dorsal surface it is received by a deep groove. The sides of this groove enfold the caudate lobe so that its exterior surface is continuous with that of the rounded main lobe. The distal ends of the two appressed lobes are hollowed to receive the anterior end of the right kidney, which they thus together surround. In Gymnura the caudate lobe is represented as long and narrow, and alone enfolding the end of the kidney. In Erinaceus the condition is much the same. The Spigelian lobe is very short and single, thus resembling that of Centetes, rather than that of the Erinaceidae in which it is generally larger in proportion and bifid. The central lobe of the liver is practically entire except for a slight fissure at its left end, visible in ventral view, but covered dorsally by the gall bladder. The dorsal surface is deeply grooved for the reception of the pyriform gall bladder, which is partially overhung by a projection of the substance of the liver. The suspensory ligament is attached along the median portion of this central lobe for some 18 mm. Posteriorly a small thread-like division of this ligament is given off to the tip of the secondary lobe separated off by the slight fissure previously mentioned at the left side of the main central lobe. The gall bladder is large and pyriform and its duct, about 30 mm. in length, opens into the small intestine in common with that of the pancreas at about a centimeter from the pylorus.

The pancreas (Plate 9, fig. 7) is a large structure with very definite outline, and consists of two main lobes. The one is elongate, about 55 mm. in length by 15 in width, and of a slightly reddish color. The other is subtriangular, and much more solid in consistency, becoming decidedly thickened at the free rounded apex. The duct is confluent with that from the gall bladder at about 6 mm. from the opening into the small intestine. There are no secondary pancreatic ducts. The great size and solidity of the pancreas are noteworthy in *Solenodon paradoxus*. The slight and racemose structure figured for this organ in *S. cubanus* (Peters, '64, Plate 2, fig. 10) is quite different and may be the result of partial decomposition. In its bilobed character and the stoutness of the large triangular portion, the pancreas of *S. paradoxus* seems to bear much resemblance to that of Chrysochloris.

Glands.— The spleen (Plate 9, fig. 5) is a large flattened mass of a dark red

color attached by delicate mesentery to the cardiac curvature of the ventral portion of the stomach. Its left end curves dorsally, slightly enfolding this part of the stomach, and forms a recurved lobe. When removed and spread out there is seen to be a slight constriction forming another terminal lobe at its right end. These lobes are not indicated by Peters in his drawing of the spleen of *S. cubanus* but otherwise the two organs appear similar.

There is a large mesenteric gland (Plate 9, fig. 6) above the rectum, in the dorsal mesentery, about a centimeter posterior to the left kidney. It is 13 mm. long by 6.5 mm. in greatest width, with slightly lobulate border and a posterior notch for the insertion of a vessel. Other smaller glands are present, 2 or 3 mm. long, scattered throughout the great mesentery, particularly in the region of the stomach, where close to the pylorus is a large gland about 5 mm. long.

The thyroid glands (Plate 5, fig. 1, *t*) are remarkably large, situated one on each side of the throat, posterior to the submaxillary glands. They are oval in shape and in one specimen, measured 22 by 9.5 mm., and 18 by 9 mm. respectively.

The thymus (Plate 9, fig. 1, *t*) is a large median glandular mass partially investing the base of the trachea ventrally just anterior to the heart. It consists of two rounded lobes, one on each side, bound together by connective tissue. The greatest median length of the mass is about 11 mm.

In addition to these, there is a glandular mass at the axilla and another just in front of the hip joint. The latter is rather large, and divided into two main masses, about 21 and 15 mm. long respectively, and each about a third as wide as long. These, as stated by Peters, may be lymphatic glands, or possibly scent glands. They were discovered by Poey in fresh specimens of *Solenodon cubanus*. There are no anal glands such as are found in Gymnura.

Fresh specimens show no skin glands. What Dr. J. A. Allen (:08, p. 513, fig. 8) has figured as a "glandular surface of left thigh" is apparently the result of partial maceration of the hair follicles at that region. These are very large and conspicuous and might readily be mistaken for the openings of glands. In fresh specimens, however, there is no trace of such an area, but the entire surface is well haired.

Mesenteries.— The great mesentery suspending the intestine from the dorsal body wall is continuous for practically the entire length of the gut, and shows no special modification. A short narrow mesentery connects the liver and the small intestine and is continuous with a delicate membrane along the lesser curvature of the stomach.

Lungs.— The lungs (Plate 9, fig. 1) of *Solenodon paradoxus* are capacious and the pleural cavity extends back as far as the 15th rib. At this point the diaphragm arises from the body wall and passes obliquely forward on each side, along the ventral edges of the sternal ribs to the base of the xiphisternum. The lobes of the left lung seem a trifle smaller than those of the right. The left lung is divided into three simple lobes of which the anteriormost is the least, the posteriormost the greatest. The right lung has in addition to the three main divisions corresponding to those of the other side, a well developed azygos lobe arising from the base of the large third lobe. The second lobe differs from that of the left side in having a transverse fissure by which it is divided into an anterior and a posterior portion. Peters figures no azygos lobe in the lungs of *S. cubanus*, and the left middle lobe seems to be more elongated transversely. Apparently *S. paradoxus* resembles Centetes in the character of the lung. Erinaceus is remarkable in having a simple, undivided left lung and greatly elongated azygos lobe. In Gymnura and Chrysochloris the left lung is divided into two lobes and the azygos lobe is more like that of *S. paradoxus*, in which a further step has been taken by the development of a third lobe at the anterior end of the left lung. The lungs of Potamogale are described as essentially similar to those of Centetes.

Heart and its vessels.— The ventricles of the heart (Plate 9, fig. 2) form a rounded mass about 25 mm. long. The right auricle is noticeably larger than the left, with thicker walls. The aorta arises as a large trunk from the right side of the heart, and at the point where it curves to the left side, sends off a large branch. This after about 5 mm. divides into two large arteries, the more exterior of which is the right subclavian, the more interior the right carotid. The left carotid arises separately from the main trunk of the aorta close beyond the first large branch. The left subclavian likewise is given off independently just posterior to the last. The aorta then passes posteriorly and is joined on the ental side by the ductus arteriosus. The pulmonary arteries as usual come from the conus arteriosus. The arrangement of the vessels is thus practically the same as in Centetes, Potamogale, Chrysochloris, and Myogale.

Excretory and genital organs.— The kidneys are similar in both sexes. They are large oval bodies in the usual position against the body wall of the lumbar region, that of the right side slightly anterior to that of the left. The ureters are slender tubes leading as usual to the bladder on each side. The adrenal bodies are oval, each about one third the length of the kidney, and closely appressed along its antero-median border from the hilum nearly to the anterior end (Plate 9, fig. 9).

The testes of the male are oval glands about 9 by 6 mm. bound by a short and rather broad ligament 10 mm. long, to the abdominal wall on either side a few millimeters above and anterior to the symphysis pubis. A long filamentous ligament likewise passes from the attached end of each testis to the posterior region of the adrenal body of each side. The testes are somewhat sunken into perineal sacs, but still wholly internal. The spermatic cords pass ventromedially and the vasa deferentia unite at the base of the bladder. The prostrate glands are small, oval, and united medially on the ventral side just caudad of this point, much as in Centetes. No trace of Cowper's glands could be discovered though their presence may have been overlooked. The penis is retractile and is carried forward along the abdominal wall to about 2 cm. from the anus. As stated by Dobson, this is an important difference in comparison with the condition found in the Centetinae and Potamogalinae in which the penis is retractile within the cloaca. The testes, too, in the Centetinae, are found much farther forward.

The ovaries (Plate 9, fig. 8) in the adult female examined are small bodies about 3 mm. in length, dark brown in color. They are mainly suspended by the ovarian ligament, a thick filament extending along the anterior edge of each broad ligament of the uterus. The Fallopian tubes are short and convoluted, and pass at once into the cornua which are each about 15 mm. long. The posterior position of the ovaries is again different from that found in the Centetidae in which they are close to the kidneys. The uterus is very long and narrow measuring about 40 mm. in length. It is suspended by the usual two ligaments: the broad or ligamentum latum from the body wall to the cornua, and the round or ligamentum rotundum, that bounds the posterior free edge of a fold of the broad ligament, between which and the body wall there is thus formed a shallow diverticulum. The round ligament is inserted just caudad to the cornu of each side, and passes to the body wall about midway on the anterior edge of the pubis. The genital organs of the Cuban Solenodon appear to resemble in essential points, those of the San Domingo species.

BRAIN.

The brain of Solenodon has been hitherto unknown. This organ was removed from one of the specimens and though somewhat softened, it showed a number of interesting conditions (Plate 6, figs. 8, 9). Its general outline is much like that of the brain of Centetes as figured by Leche (:07, p. 102), with

almost straight, posteriorly diverging cerebral margins, instead of the outwardly bowed boundaries seen in Erinaceus, and Hemicentetes, or the concave outlines of Chrysochloris. The olfactory lobes are more oval, as in Hemicentetes (Leche, :07, p. 102, fig. 87) and the constriction between them and the cerebral hemispheres is very shallow in comparison with the condition in the Centetidae. The cerebral lobes do not extend back so far, relatively, as in Centetes, for the opticus and post-opticus are visible in dorsal view, as is true also of Erinaceus. There is a single well marked lateral sulcus on each of the hemispheres as in the latter, and in addition an ill defined sulcus dorsal to this, which may have been the result of poor preservation. The cerebrum of Centetes is represented as quite smooth. The cerebellum is longer in proportion than in Centetes, but otherwise much similar with a prominent vermis bounded posteriorly by a deep notch, and with pointed lateral prolongations directed forwards. In median section, directly ventral to the center of the cerebellum, two slight transverse grooves mark off a well defined pyramis and anterior to it a broader pons.

PLEXUSES.

The brachial plexus (Plate 6, figs. 7, 10) in *Solenodon paradoxus* is chiefly made up of trunks from the sixth, seventh, and eighth cervical nerves and the first dorsal nerve. In one individual, a slender filament was present from the base of the fifth cervical nerve passing posteriorly and receiving two minute threads from the sixth cervical nerve. In *Solenodon cubanus* Dobson found the fifth cervical to enter into the plexus as a major element. More or less variation is to be expected in the details of the arrangement of the nerves, but the chief connections were nearly identical in the specimens examined. The sixth nerve passes distally as a single trunk with a large basal branch to the seventh cervical nerve. In one instance this connecting branch had the appearance of a fusion of a basal branch from both nerves, but in the other the dual nature of the connection was less clear. The lateral branch of the sixth nerve appears to correspond with that supplying the subscapular and teres muscles. The seventh cervical, in addition to the short connection with the sixth, and a similar with the eighth, from the latter of which a common trunk passes off, has a more distal bifurcation, the posterior branch of which unites with a large branch from the eighth cervical. The main portion of the eighth unites with the first dorsal nerve to form a single short trunk, which soon gives off a small posterior branch, the internal cutaneous. The plexus in Solenodon is rather

simple and resembles that of Potamogale and Chrysochloris in being composed of the last three cervical and first dorsal nerves, with the partial exception of the one instance mentioned in which a slender thread from the fifth cervical entered the complex. In *Solenodon cubanus* the fifth cervical nerve seems to enter as a major element of the plexus and the same is true in the Centetidae. This fact is of interest in connection with the additional dorsal vertebra in *Solenodon paradoxus* as compared with the more specialized condition in *S. cubanus.*

The lumbo-sacral plexus (Plate 6, figs. 2, 3) of *S. paradoxus* was dissected in three individuals and found to differ from that figured by Dobson for *S. cubanus.* The chief nerves composing the plexus are the second, third, and fourth lumbars, and the first sacral. In Centetes the second sacral in addition enters into the complex, and this was found to be the case in one of the specimens of *Solenodon paradoxus.* The anterior crural and the obturator nerve arise mainly as branches of the second lumbar in two individuals while in a third they are from the third lumbar. In this specimen the great sciatic is nevertheless, mainly from the fourth lumbar as in the two other individuals. Dobson's figure of the lumbar plexus in *S. cubanus* shows the anterior crural and the obturator arising together as in *S. paradoxus,* but from the *fourth* lumbar while the sciatic is composed of trunks from the first two sacrals. It is possible that confusion has arisen in numbering the several trunks, as otherwise the condition in the two species is the same. In *S. paradoxus* all the lumbar nerves virtually enter into the plexus by the first lumbar nerve sending a minute filament posteriorly to unite with the next following nerve as it issues from its foramen.

SUMMARY.

In external and cranial characters, *Solenodon paradoxus* differs very markedly from *S. cubanus* as has been recently pointed out by Dr. J. A. Allen (:08), who has suggested that these differences may be considered of subgeneric value. In view of his careful summary, it is needless to repeat his conclusions here. It may be added, however, that the presence of a white nape spot is a fairly constant character of *S. paradoxus,* instead of an individual variation as seemed to be indicated by the specimens heretofore known. Further, the supposed glandular surface of the thighs is an appearance apparently due to poor preservation. The presence of long coarse hairs in the pelage in addition to the finer ones in *S. paradoxus* may indicate a step toward the spiny condition of certain other Insectivora.

The muscular anatomy of the two species is essentially similar although in case of the Cuban Solenodon, our knowledge is still somewhat imperfect, and rests almost wholly on the account by Dobson. This author fails to describe in *S. cubanus* a stylo-hyoid, though it may be present as in *S. paradoxus*. Other differences found in the latter as compared with Dobson's description of *S. cubanus* are: a single head to the biceps instead of two; a second head to the gluteus maximus arising from the ilium; slight differences in the insertion of the adductor longus; the union of the soleus with gastrocnemius. Additional peculiarities are the insertion of tibialis anticus upon the entocuneiform instead of on the first metatarsal; the insertion of peroneus longus upon metatarsals 1 and 5; the insertion of tibialis posticus upon the os calcis instead of upon the naviculare as in *S. cubanus* and other allied genera.

Osteological differences beyond those emphasized by previous writers who have compared the skulls only, are: 16 instead of 15 dorsal vertebrae and thus an additional rib in *S. paradoxus*; one less segment to the sternum and a differently shaped xiphisternum; the separation of the radiale and the intermedium, which are said by Dobson to be fused in *S. cubanus*; the distal fusion of the tibia and fibula, described as separate in *S. cubanus*. The proximal expansion of the entocuneiforme to articulate ventrally with the anterior end of the os calcis is also a peculiarity not previously noted, though it may be similarly developed in the Cuban animal. The number of sacrals is probably the same in both species, since the fifth sacral figured by Peters for the latter, seems to be a fused caudal.

Other differences are noted in the visceral anatomy, such as the number of palatal rugae, which are normally eight in number, whereas nine are figured by Peters for *S. cubanus*; the presence of a rounded azygos lobe to the right lung is not noted by Peters, and his figures of the stomach and pancreas show slight differences that may be in part due to poor preservation. The Cuban Solenodon appears further to differ from *S. paradoxus* in that the fifth cervical nerve enters as a major element into the brachial plexus. The plexuses, however, are subject to some slight variation, and additional specimens might show that this is not a constant difference.

Among the less specialized Insectivora, characterized by tritubercular molars, the two species of Solenodon possess characters that abundantly warrant their separation as a family, as has been emphasized by previous writers. Undoubtedly their position is near the Centetidae, from which they differ in a number of specialized characters, as the position of the penis, the differentiation

of the teeth, the development of the snout, the ankylosis of tibia and fibula (at least in *S. paradoxus*). On the other hand Solenodon possesses many generalized characters in common with Centetes, Potamogale, Gymnura, and even Myogale, the two latter of which are the most generalized members of their respective families. Leche (:07) is doubtless correct in making Potamogale the representative of a subfamily (Potamogalinae) of Centetidae, since the loss of clavicles and certain other peculiarities usually emphasized as distinctive, are probably the result of adaptation to an aquatic existence, while the general simplicity of structure and the common anal and genital opening certainly ally it closely to the Centetinae. On the other hand, Potamogale bears considerable superficial resemblance to Solenodon and Myogale in the form of the skull and teeth, and it seems probable that all three represent divergent lines of descent from some common stock.

LITERATURE.

ALLEN, J. A.

:08. Notes on *Solenodon paradoxus* Brandt. Bull. Amer. mus. nat. hist., 1908, **24**, p. 505–517, pls. 28–33.

BRANDT, J. F.

'33. De Solenodonte, novo mammalium insectivorum genere. Mém. Acad. imp. sci. St. Pétersbourg, 1833, ser. 6, **2**, p. 459–478, pls. 1, 2. Also separate, p. 1–20, pls. 1, 2.

DOBSON, G. E.

'82–'90. A monograph of the Insectivora, systematic and anatomical. London, 1882–1890, 4to, iv + 172 pp., 28 pls.

GREGORY, W. K.

:10. The orders of mammals. Bull. Amer. mus. nat. hist., 1910, **27**, p. 1–524.

LECHE, W.

:02. Zur entwicklungsgeschichte des zahnsystems der säugethiere, zugleich ein beitrag zur stammesgeschichte dieser thiergruppe. Zweiter theil: Phylogenie. Erstes heft: Die familie der Erinaceidae. Zoologica, 1902, part 37, 104 pp., 4 pls., 59 text-figs.

:07. Zur entwicklungsgeschichte des zahnsystems der säugetiere. Zweiter Teil: Phylogenie. Zweites Heft: Die familien der Centetidae, Solenodontidae und Chrysochloridae. Zoologica, 1907, part 49, 158 pp., 4 pls., 108 text-figs.

PARSONS, F. G.

'98. The limb myology of *Gymnura rafflesii*. Journ. anat. phys., 1898, **32**, p. 312–324.

PETERS, W.

'64. Ueber die säugethier-gattung Solenodon. Abh. Kön. akad. wissensch. Berlin, 1863, 1864, p. 1–22, pls. 1–3.

POEY, F.

'51. Memorias sobre la historia natural de la isla de Cuba (on *Solenodon cubanus*). Habana, 1851, **1**, p. 23–41, pl. 1.

VERRILL, A. H.

:07. Notes on the habits and external characters of the Solenodon of San Domingo (*Solenodon paradoxus*). Amer. journ. sci., ser. 4, **24**, p. 55–57, 1 fig. Also Ann. mag. nat. hist., 1907, ser. 7, **20**, p. 68–70, pl. 4.

EXPLANATION OF PLATES.

PLATE 1.

Fig. 1.—Young female three days old. $\times 1\frac{1}{5}$.
Fig. 2.— Young female with hairy coat complete. About $\frac{2}{3}$ natural size.

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PLATE 2.

Adult male in the rufous phase. About ½ natural size.

PLATE 3.

Adult female in the pale phase. About $\frac{5}{8}$ natural size.

PLATE 4.

Fig. 1.— Superficial muscles of the thorax. *a*, clavo-trapezius; *b*, supracervico-cutaneus; *c*, acromio-trapezius; *d*, spino-trapezius; *e*, dorso-cuticularis; *f*, latissimus dorsi; *g*, epitrochlearis; *h*, teres. × 1.

Fig. 2.— Muscles of the hind legs, ventral view. *a*, rectus femoris; *b*, vastus internus; *c*, adductor longus; *d*, semimembranosus; *e*, adductor brevis; *f*, semitendinosus; *g*, gracilis; *h*, quadratus femoris; *i*, flexor longus hallucis; *j*, tibialis posticus; *k*, adductor quartus; *l*, flexor longus digitorum pedis; *m*, adductor magnus; *n*, pectineus; *o*, psoas magnus; *p*, psoas parvus. × 1.

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PLATE 5.

Fig. 1.— Side view of head muscles. *a*, levator labii superioris et erector vibrissarum; *b*, zygomaticus major; *c*, levator labii superioris proprius; *d*, small muscle corresponding to Dobson's second head of temporalis; *e*, temporalis; *f*, digastric; *g*, masseter; *p*, parotid gland; *s*, submaxillary gland; *t*, thyroid. × 1.

Fig. 2.— Section of cartilaginous proboscis near tip. × 1½

Fig. 3.— Hyoid muscles. *a*, mylo-hyoid; *b*, stylo-hyoid; *c*, digastric; *d*, sterno-thyroid; *e*, crico-thyroid; *f*, sterno-hyoid; *g*, manubrium of the sternum. × 1

Fig. 4.— Pectoral and cervical muscles. *a*, levator claviculae; *b*, occipito-scapularis; *c*, clavicular portion of ectopectoralis; *d*, subclavius; *e*, ectopectoralis; *f*, entopectoralis; *g*, sterno-mastoideus; *h*, cleido-mastoideus. × 1.

Fig. 5.— Ental aspect of shoulder muscles. *a*, subscapularis; *b*, teres; *c*, coracoideus; *d*, epitrochlearis; *e*, latissimus dorsi; *f*, serratus magnus; *g*, levator anguli scapulae. × 1.

Fig. 6.— Ectal aspect of scapular and forearm muscles. *a*, micostalis; *b*, meditriceps; *c*, ectotriceps; *d*, brevis division of entotriceps; *e*, cephalic division of entotriceps; *f*, combined intermedia and caudalis divisions of entotriceps; *g*, insertion of deltoid muscle; *h*, infraspinatus; *i*, supraspinatus. × 1.

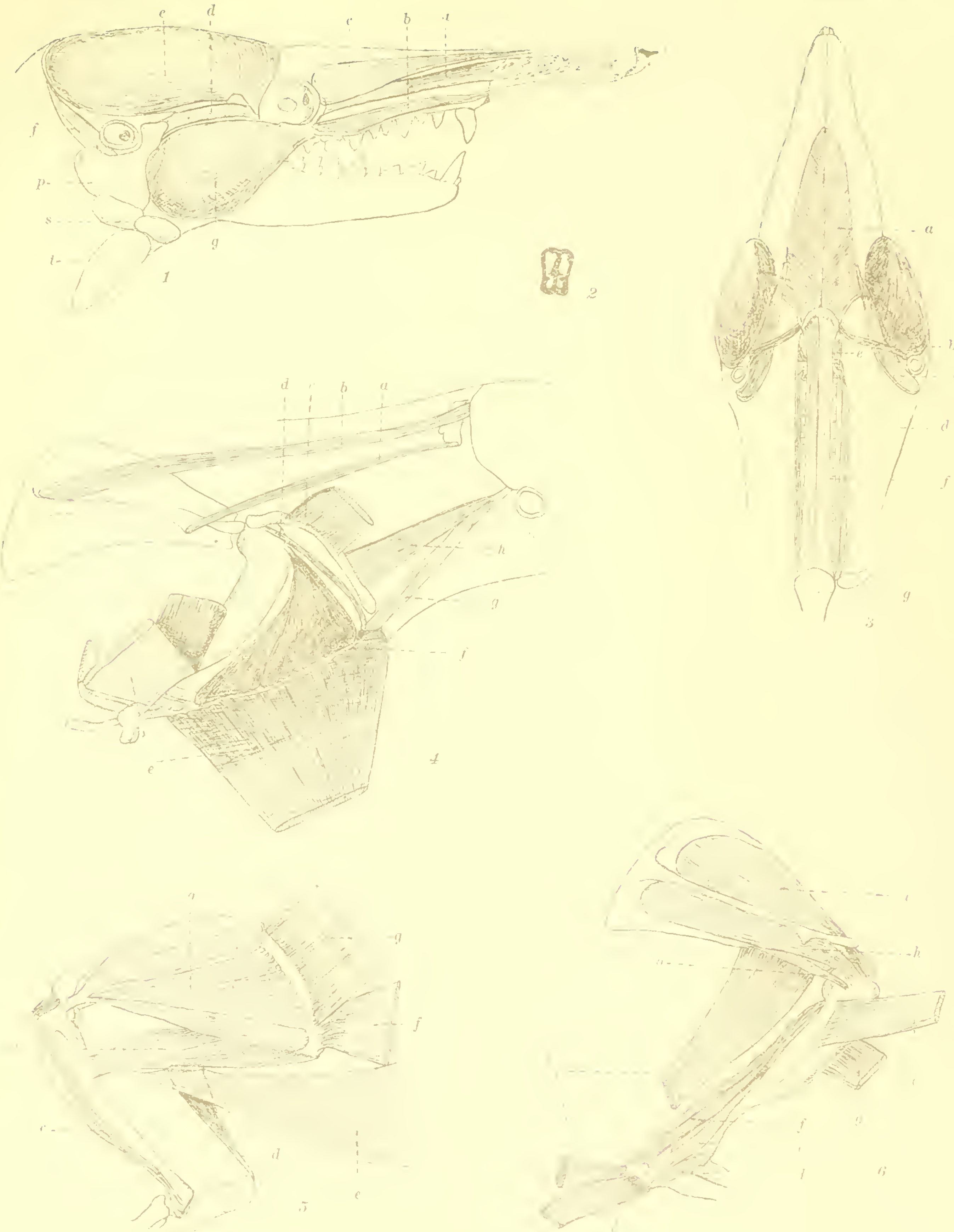

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PLATE 6.

Fig. 1.— Muscles of right hind leg, ectal aspect. *a*, gluteus minimus; *b*, posterior division of gluteus medius; *c*, gluteus maximus; *d*, semitendinosus, from two heads; *e*, gastrocnemius; *f*, peroneus longus; *g*, extensor longus digitorum; *h*, tibialis anticus; *i*, biceps femoris; *j*, crureus; *k*, vastus externus; *l*, rectus femoris; *m*, second head of gluteus maximus from the ilium; *n*, gluteus medius. × 1.

Figs. 2, 3. Lumbosacral plexuses of two individuals, showing variation. *a*, anterior crural nerve; *o*, obturator; *s*, sciatic. × 1.

Fig. 4.— Ectal view of gastrocnemius showing its two heads and its union with the soleus. *a*, soleus. × 1.

Fig. 5.— Forearm muscles from dorsal aspect. *a*, extensor digitorum communis; *b*, extensores radialis longior et brevior; *c*, pronator teres; *d*, extensor ossis metacarpi pollicis; *e*, extensor carpi ulnaris; *f*, indicator; *g*, extensor minimi digiti. × 1.

Fig. 6.— Forearm muscles from ventral aspect. *a*, flexor sublimis digitorum; *b*, flexor carpi radialis; *c*, flexor carpi ulnaris; *d*, flexor profundus digitorum. × 1.

Figs. 7, 10.— Brachial plexuses of two individuals. v–viii, fifth to eighth cervical nerves; i, first dorsal nerve. × about 3.

Fig. 8.— Brain, dorsal view. × 1.

Fig. 9.— Brain, sagittal section. × 1.

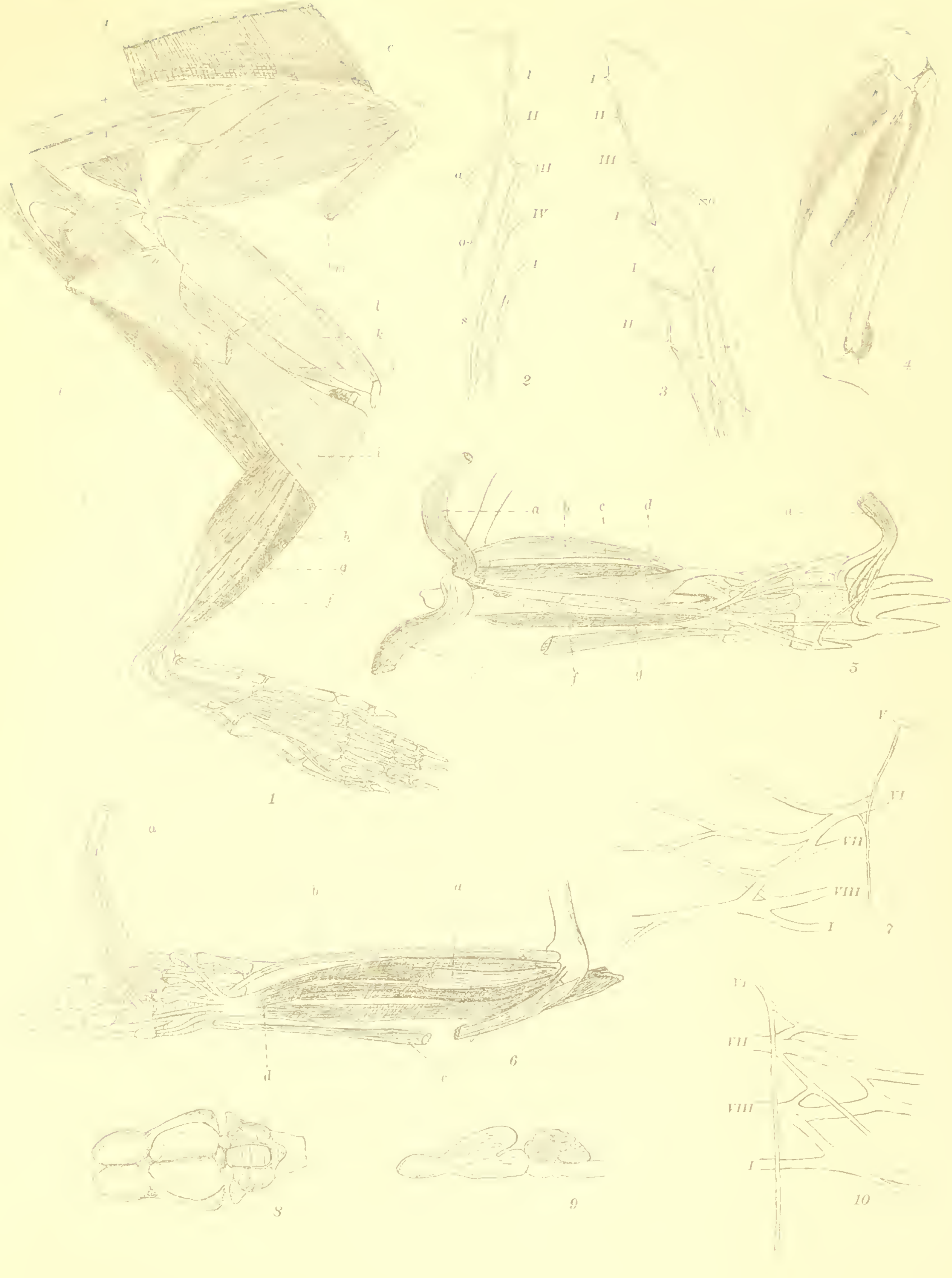

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PLATE 7.

Fig. 1.— Skull, ventral aspect. *l*, lateral snout cartilage; *o*, os proboscidis; *p*, cartilaginous proboscis. × 1.

Fig. 2.— Skull, lateral view; lettering as in Fig. 1. × 1.

Fig. 3.— Hyoid apparatus, lateral view. *b*, fused basi- and thyrohyals; *c*, ceratohyal; *cr*, cricoid; *e*, epihyal; *s*, stylohyal; *t*, thyroid. × 2.

Fig. 4.— Atlas, dorsal view. × 1.

Fig. 5.— Atlas, anterior view. × 1.

Fig. 6.— Right ramus, lateral aspect. × 1

Fig. 7.— Lower left incisors 1 and 2, showing the deep sulcus on the ental face of the latter. × 2.

Fig. 8.— Axis, lateral view. × 1

Fig. 9.— Axis, anterior view. × 1.

Fig. 10.— Abnormal seventh cervical, with vertebral arch on left side complete. × 1.

Fig. 11.— Sternum, clavicle, and sternal portions of ribs, ventral view. × 1.

Fig. 12.— Dorsal vertebrae, ribs, sternum, clavicle, right lateral aspect. × 1.

Fig. 13.— Lumbar vertebrae, right lateral view. × 1.

Fig. 14.— Lumbar vertebrae, dorsal view. × 1.

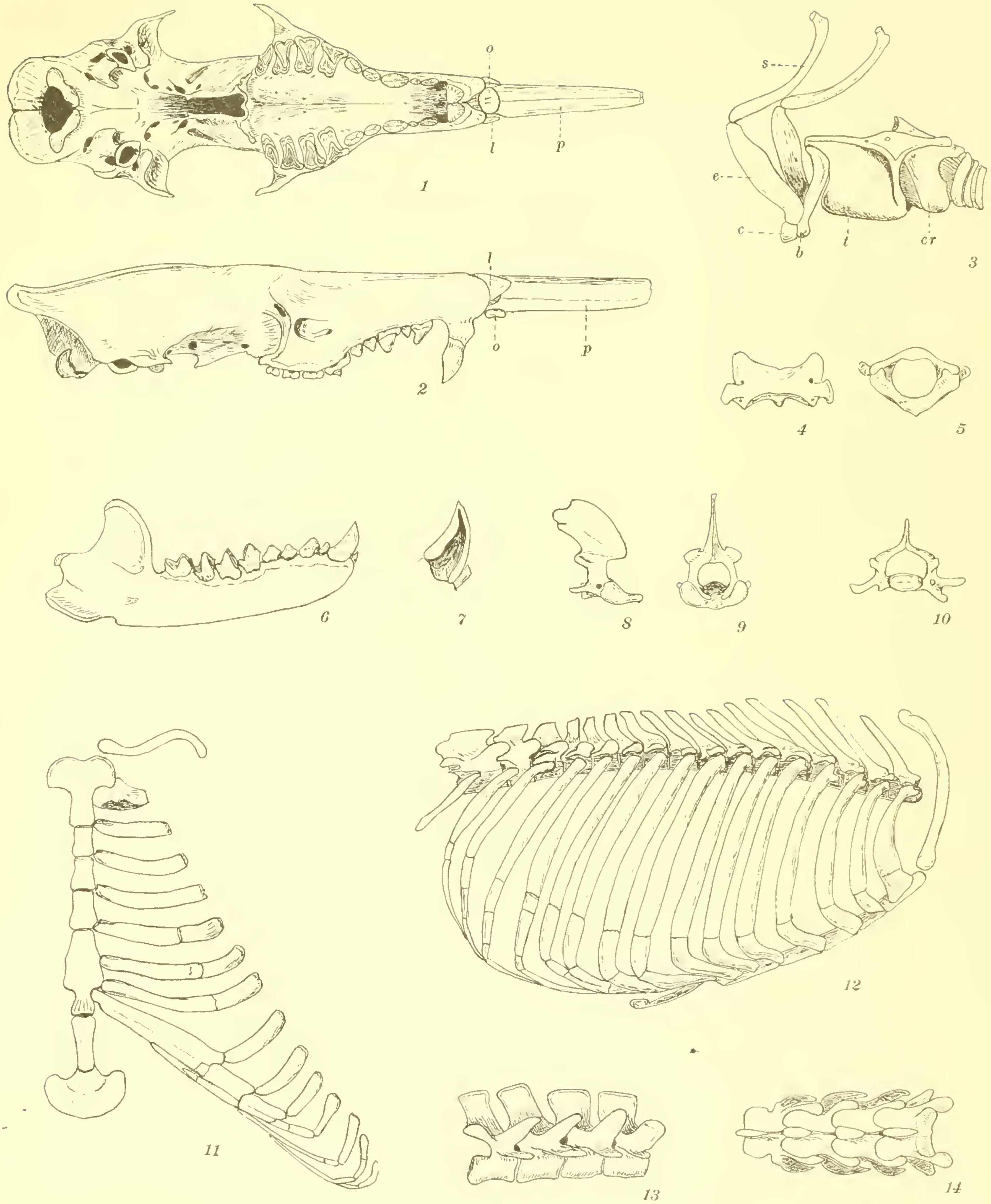
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PLATE 8

Fig. 1.— Sacral vertebrae and pelvis, right lateral view. × 1.
Fig. 2.— Sacral vertebrae and pelvis, dorsal view. × 1.
Fig. 3.— Six first caudal vertebrae, dorsal view. × 1.
Fig. 4.— Six first caudal vertebrae and chevron bones, ventral view. × 1.
Fig. 5.— Scapula of right side, ectal aspect. × 1.
Fig. 6.— Six first caudal vertebrae and chevron bones, lateral aspect. × 1.
Fig. 7.— Scapula of right side, ental aspect. × 1.
Fig. 8.— Scapula of right side, dorsal view, showing width of mesoscapula. × 1.
Fig. 9.— Humerus of right side, anterior view. × 1.
Fig. 10.— Humerus of right side, posterior view. × 1.
Fig. 11.— Humerus of right side, entolateral view. × 1.
Fig. 12.— Femur of right side, anterior view. × 1.
Fig. 13.— Femur of right side, posterior view. × 1.
Fig. 14.— Fused tibia and fibula of right side, anterior view. × 1.
Fig. 15.— Bones of right forearm, carpus, and manus, ectal aspect. × 1.
Fig. 16.— Tarsus and pes of right side, dorsal view. × 1.

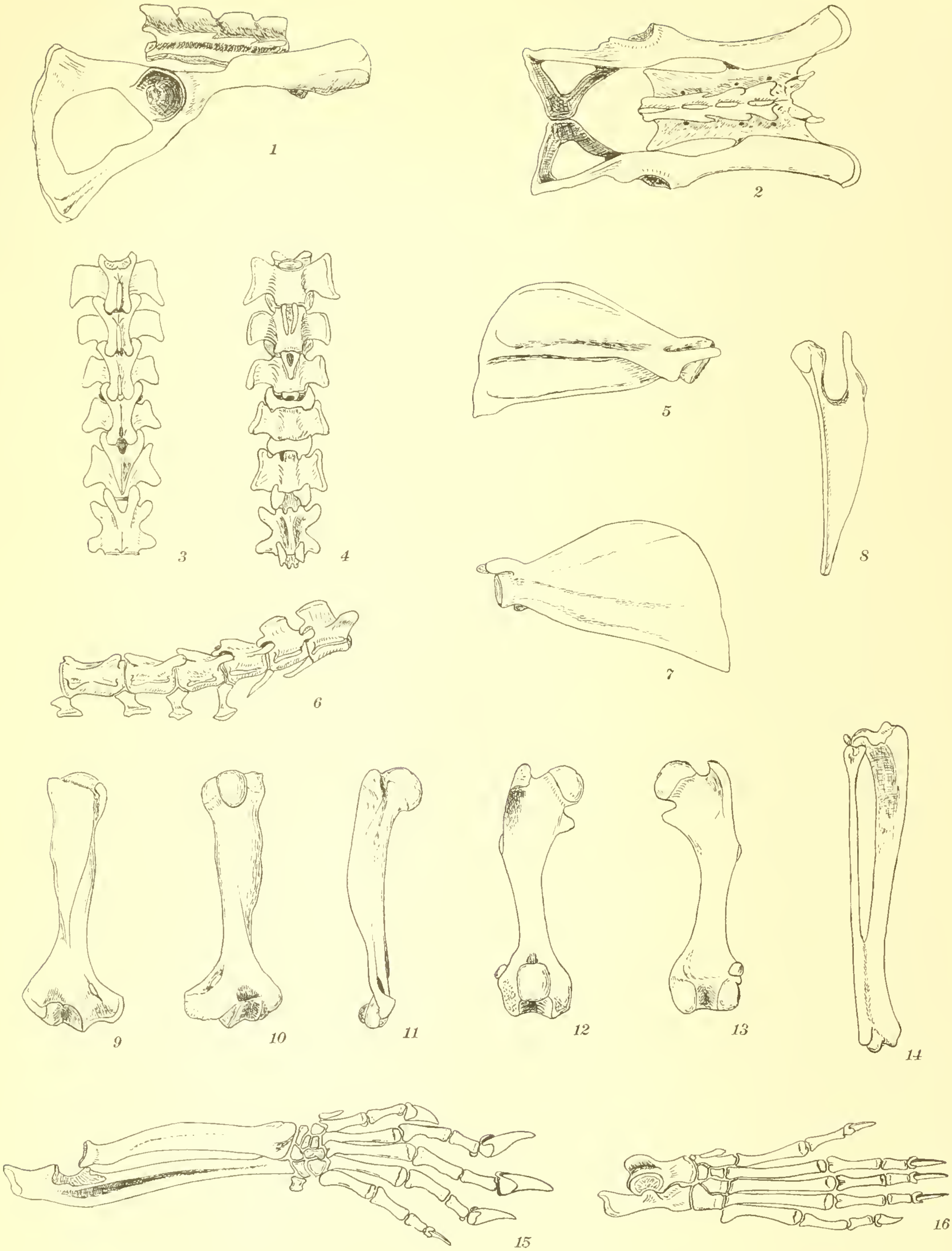
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PLATE 9.

Fig. 1.— Heart, lungs, trachea, and hyoid apparatus, ventral view. *a*, azygos lobe of right lung; *t*, thymus. × 1.

Fig. 2.— Heart and arterial trunks, ventral view. *c*, right carotid; *c'*, left carotid; *d*, ductus arteriosus; *s*, right subclavian; *s'*, left subclavian; *v*, vena cava. Slightly enlarged.

Fig. 3.— Liver, dorsal view, slightly spread out. *c*, caudate lobe lying in a depression of the right lobe; *g*, gall bladder; *i*, small intestine; *p*, pancreatic duct, cut short above its union with the bile duct; *s*, Speigelian lobe. × 1.

Fig. 4.— Tongue, dorsal view. × 1.

Fig. 5.— A large spleen, somewhat spread out. × 1.

Fig. 6.— Large gland in the mesentery dorsal to rectum. × 1.

Fig. 7.— Stomach and pancreas, dorsal view. *b*, bile duct, cut off above its union with pancreatic duct, *p*; *p*, pancreatic duct; *s*, spleen, partly enfolding cardiac end of stomach. × 1.

Fig. 8.— Female genital organs, ventral view. *b*, urinary bladder; *br*, broad ligament; *l*, ovarian ligament; *o*, ovary; *r*, round ligament; *u*, uterus. × 1.

Fig. 9.— Male genital and excretory organs, ventral view. *c*, crural muscles; *k*, kidney; *l*, ligament; *p*, penis; *pr*, prostate gland; *s*, suprarenal body; *t*, testis; *u*, ureters; *v*, vas deferens. × 1.

Fig. 10.— Liver, ventral aspect, somewhat spread out. *f*, fissure in central lobe; *m*, suspensory ligament. × 1.

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